

N.K.PRASAD

**PRINCIPLES
AND PRACTICE OF
COST
ACCOUNTING**

BOOK SYNDICATE PRIVATE LIMITED

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N. K. PRASAD

M.Sc., B.L., F.I.C.W.A., F.C.M.A., F.Dip. M.A.

BOOK SYNDICATE PRIVATE LIMITED
2, RAMNATH BISWAS LANE, CALCUTTA 700 009

Preface to the First Edition

The book has been designed to serve as a basic text in Cost Accounting to meet the needs of the students preparing for examinations in the subject as well as of the accountants engaged in the profession. It covers the syllabus in costing for the examinations of various accounting and other bodies, such as the Institute of Cost and Works Accountants of India, the Institute of Cost and Works Accountants, U.K., the Institute of Chartered Accountants of India, the Institute of Social Welfare and Business Management, the Institute of Chartered Secretaries, etc. and the B.Com. and M.Com. examinations of various Indian Universities.

The principles of costing have been discussed threadbare in simple language. The practical application of these principles in the present day conditions in India has been given, and attempt has been made to include the latest trends and current thoughts on the subject. These, it is hoped, will keep the student abreast of modern practice and will assist the Accountant in the industry in finding solutions to many problems which may confront him in his day-to-day work.

Throughout the book the text material is accompanied with a large number of diagrams and charts, and selected practical problems, many of which have been taken from past examination papers. Solutions to these problems have been given to explain and illustrate the theories discussed in the text. The student will also find use in the examination questions given at the end of each chapter.

The terms and definitions used in this book mainly follow those included in the January, 1966 edition of the "Terminology of Cost Accountancy", published by the I.C.W.A., U.K. To permit smooth and un-interrupted flow in reading, the terminology has, in fact, been merged with the matter.

The role of the cost accountant of today is not strictly confined to costing matters alone, and very often, he is called upon to render advice on matters related to Management Accountancy. The chapters on marginal cost, cost-volume-profit relationship, budgetary control, standard costing, inter-firm comparison, and capital investment decisions and control have been written keeping this requirement in view.

The author is indebted to S. S. N. Mukherjee, M.Com., A.I.C.W.A., for the critical review of the manuscript, and for his valuable suggestions which have contributed to the improvement of the text. Permissions given by the I.C.W.A. of India and the Institute of Chartered Accountants of India for publishing question set in past examinations and by the I.C.W.A., U.K., for making use of questions from past examination papers and the "Terminology of Cost Accountancy" are gratefully acknowledged. Thanks are also extended to my colleague Sri D. P. Ghosh, B.Sc., A.I.C.W.A., for his valuable assistance rendered.

Lastly, but not the least, the author is grateful to Sri N. K. Bose, B.Sc., F.I.C.W.A., F.C.W.A., J.Dip.M.A., D.B.A., A.C.I.S., A.M.B.I.M., President, I.C.W.A. of India, for the kind encouragement and suggestion given right from the beginning when the work on the manuscript was started, about two years ago.

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CHAPTER 1

CONCEPTS AND CLASSIFICATION OF COSTS

Starting off as a branch of financial accounting, Cost Accountancy has made rapid strides during the last few decades and has established a distinct and highly specialised framework to assist the business management in planning and controlling its operations. The techniques and procedures of cost accountancy have developed so quickly and the fields covered by it have been expanding to such magnitudes that it is difficult to attempt a suitable definition for it, which would cover all its aspects. An earlier terminology defines cost accountancy as 'the application of costing and cost accounting principles, methods and techniques to the science, art and practice of cost control and the ascertainment of profitability'. It includes the presentation of information derived therefrom for the purpose of managerial decision making'. Again, cost accounting is defined as 'the process of accounting for cost from the point at which expenditure is incurred and committed to the establishment of its ultimate relationship with cost centres and cost units'. In its widest usage, it embraces the preparation of statistical data, the application of cost control methods and the ascertainment of profitability of activities carried out or planned. These definitions while laying down the objectives of cost accountancy and the methods to achieve them, introduce terms which need explanation. These are taken up later in this chapter.

Financial Accounting and Cost Accounting. In order to appreciate fully the function, purpose and scope of cost accounting, it would be useful to examine the position of cost accounting in the broader field of general accounting and to study the relationship of cost accounting with other branches of accountancy, viz. financial accounting and management accounting. The concept in earlier days was to maintain cost records, separate and distinct from financial accounts and reconcile the two sets of accounts, financial and cost, at the end of each accounting period. As the figures required for cost accounting had to be taken mainly from the financial books and records, maintenance of cost accounts as a separate water-tight compartment was later considered unnecessary and this led to the development of the techniques of integrated accounts under which the cost and financial books are dovetailed.

Financial or traditional accounting consists of the classification, recording, and analysis of the transactions of a business in a subjective manner according to the nature of expenditure so as to enable the presentation at periodic intervals, of statements of profit or loss of the business and, on a specified date, of its financial state of affairs. The day-to-day transactions suitably journalised or recorded in subsidiary books are posted in the various ledgers and at the end of the accounting period, a Profit and Loss Account and a Balance Sheet are prepared. The emphasis is on the ascertainment and exhibition of the profits earned

or losses incurred by the business rather than on the aspects of planning and control and decision making. For the latter purpose, cost accounting records expenditure in an objective manner, i.e. according to the purpose for which costs are incurred.

The cost of manufacture of products or of rendering service is, no doubt, available in the financial accounts but only in totals and that too at the end of the accounting period. But if the cost of individual products or services and the profit or loss from each are to be pre-planned or are required concurrently as the process of manufacture or of rendering the service proceeds, recourse has to be had to cost accounting methods. A simple example will illustrate the point. The financial accounts of a concern show the following position at the end of an accounting period :-

Materials consumed	Rs. 20,000
Wages paid	Rs. 15,000
Other expenses	Rs. 15,000
	— — —
Total cost	Rs. 50,000
	— — —
Sales	Rs. 60,000
	— — —
Gross profit	Rs. 7,000

Assuming that three products, ~~Product A, Product B and Product C~~, were manufactured during the period, cost accounting records might reveal a position something like that shown below :

	Product A	Product B	Product C	Total
	Rs.	Rs.	Rs.	Rs.
Materials	7,000	8,000	5,000	20,000
Wages	8,000	5,000	2,000	15,000
Other Expense	10,000	6,000	2,000	18,000
	— — —	— — —	— — —	— — —
Total cost	25,000	19,000	9,000	53,000
	— — —	— — —	— — —	— — —
Sales	30,000	18,000	12,000	60,000
	— — —	— — —	— — —	— — —
Gross Profit	5,000	(—) 1,000	3,000	7,000

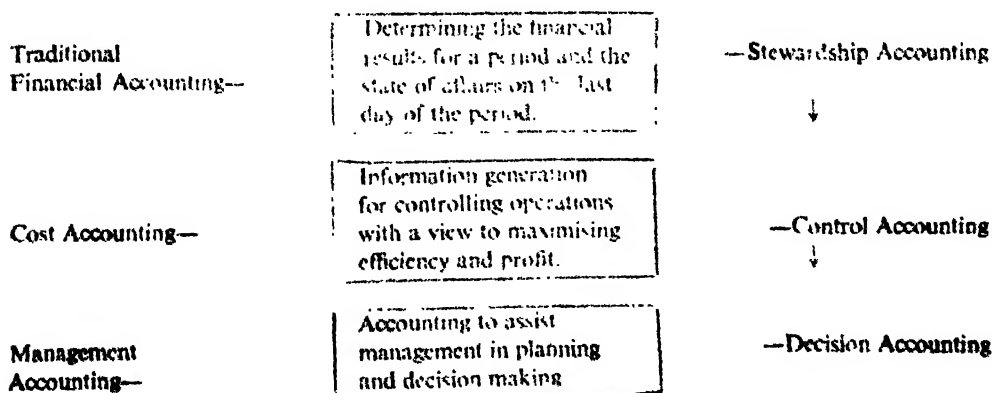
Although the total gross profit for the year was Rs. 7,000, the cost records show that product B incurred a loss of Rs. 1,000, a position which financial accounts as such failed to readily reveal.

Another aspect which distinguishes cost accounting from financial accounting is the diversity of purpose. Financial accounting safeguards the interests of the business and its proprietors and others connected with it by providing suitable accounts information to various parties, such as the share-holders or partners, present and prospective creditors and the Government. The accounts are kept in such a manner as to meet the provisions of the Companies Act and to present correct figures to income tax, excise and other authorities. These accounts show how gainfully the resources of the business were employed but do not give clear indication to the management as to what should be done in particular situations. Cost accounting on the other hand, renders information for the guidance of the

management for proper planning, operation, control, and decision making. For example, while financial accounts show whether materials purchased have been correctly accounted and paid for, whether there has been any loss during storage and whether the opening and closing balances of stock are correct, cost accounting reveals matters such as, whether the quantity purchased is reasonable, whether the purchase is at all necessary, whether a component or part should be manufactured internally instead of being purchased, whether the quantity of material utilized is reasonable and whether there is any loss or wastage in production. Similar considerations would apply to the utilization of labour, capital and other resources.

Apart from these, the feature which distinguishes cost accounting from financial accounting is the forward looking approach of the former whereby future costs are guided and controlled through various techniques. These will be discussed later.

Cost Accounting and Management Accounting. In recent years, another aspect of accounting known as *Management Accounting* (now also being referred to as *Managerial Accounting* by some) has been developed which is being used in many business concerns. Management accounting includes all those accounting services by means of which assistance is rendered to the management at all levels, in formulation of policy, fixation of plans and control of their execution, and measurement of performance. Management accounting is primarily concerned with the supply of information which is useful to the management in decision making for the efficient running of the business and in maximising profit. Management accounting employs various techniques which include standard costing, budgetary control, marginal costing, break-even and cost-volume-profit analysis, uniform costing and inter-firm comparison, ratio accounting, internal audit, and capital project assessment and control. The objectives of cost accounting are similar to those of management accounting and as the cost accountant uses most of the aforesaid techniques for his work, cost accounting may be considered to be a major complement of management accounting. In fact, management accounting is an extension of the managerial aspects of cost accounting; it utilizes the principles and practices of both cost accounting and financial accounting in the best interests of the business. The evolution of management accounting may be traced as follows :—



Costing or Cost Ascertainment. Costing refers to the techniques and processes of ascertaining costs, the methods used and the actual process of cost finding. Before proceeding further with the discussion of the process of costing, however, it will be necessary to state what is meant by cost. Cost is defined as (a) the amount of expenditure (actual or notional) incurred on, or attributable to a given thing, or (b) to ascertain the cost of a given thing. The first definition refers to cost as the objective or the end product which finally results from a process of costing. The second definition relates to the process itself, i.e. the ascertainment of cost.

The technique of costing involves two fundamental steps, namely:

- (i) collection and classification of expenditure according to the cost elements and
- (ii) allocation and apportionment of the expenditure to the cost centres or cost units.

On a reference to the second table on Page 2, it will be seen that the total expenditure of Rs. 25,000 is classified into the elements (materials, wages and other expenses) and then the cost against each element is allocated or apportioned to the three products A, B and C to give the cost of each. If the number of units manufactured is given, the cost per unit for each of the products can be determined. For example, if 100 units of product A were manufactured, the cost would be as follows:—

COST OF PRODUCT A		Product B 100 Units	
	Total Cost		Per Unit
Materials	Rs. 7,000	Rs.	70
Wages	Rs. 8,000	Rs.	80
Other expenses	Rs. 10,000	Rs.	100
	Rs. 25,000	Rs.	250

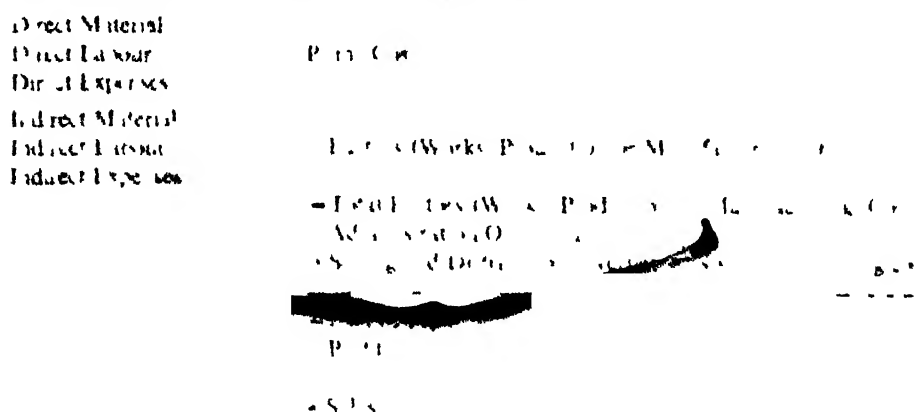
Elements of Cost. A manufacturing organisation is concerned with the conversion of raw materials into finished products with the help of labour and certain other services. In order to compute the cost of each of these functions, the cost of manufacturing a product is subdivided into what are known as elements of cost. Thus, elements of cost are the primary classifications of costs according to the factors upon which expenditure is incurred. Break up of cost into its elements is essential for the purpose of accounting and for cost control.

The elements of cost are composed of (i) Material cost, i.e. the cost of commodities supplied to the undertaking, (ii) Wages or labour cost, i.e. the cost of remuneration (wages, salaries, commission, bonus etc.) of the employees of the undertaking, and (iii) Expenses, i.e. the cost of services provided to the undertaking and the notional cost of the use of owned assets. Each of these elements is further subdivided into direct and indirect costs as follows:

Material	Direct material
	Indirect material
Labour —	Direct labour
	Indirect labour
Expenses —	Direct expenses
	Indirect expenses

The distinction between direct and indirect costs will be discussed later. It will suffice to state here that direct material, direct labour and direct expenses are costs traceable to cost centres, products or jobs but indirect material, indirect labour and indirect expenses are material and labour costs and other expenses which cannot be so traced in a direct manner.

The aggregate of direct material cost, direct wages (or direct labour cost) and direct expenses is termed, Prime Cost and the aggregate of indirect material cost, indirect wages (or indirect labour cost) and indirect expenses is known as Overhead Cost. Overhead cost is further subdivided into Factory (or Works Production or Manufacturing) Overhead, Administration Overhead and Selling and Distribution Overhead. The classification is shown as follows:



Cost Centre and Cost Unit. As stated earlier, costs are ascertained by Cost Centres or by Cost Units or by both.

Cost Centre is defined as a location, person or item (or a unit or group of these) for which cost may be ascertained and used for the purpose of cost control. It follows that cost centres are of two types, viz. Impersonal and Personal cost centres. An Impersonal Cost Centre consists of a location or item of equipment (or group of these) and a Personal Cost Centre consists of a person or group of person. A cost centre determined according to location may be an area or region of sales, a depot or warehouse. Such cost centres are mainly related to selling and distribution costs and are thus applicable to sale of products.

In a manufacturing concern, the cost centres generally follow the pattern or layout of the departments or sections of the factory and accordingly, there are two main types of cost centres as indicated below:

- Production or Producing Cost Centres.** These centres are engaged on production work. The raw materials are handled here and converted into saleable products. In such centres, both direct and indirect costs are incurred. Machine shops, welding shops and assembly shops are examples of production cost centres in a factory manufacturing engineering goods.
- Service Cost Centres.** These centres are ancillary to and render service to producing cost centres. Only indirect costs are incurred in Service Cost Centres and saleable products are not usually handled in these centres. In the case of certain Service Cost Centres like power

electricity or gas) may not be captive and product units in excess of the factory's own requirements may be sold. A few examples of Service Cost Centres are

- (i) Material service centres dealing with handling and upkeep of stores, e.g. Stores, Internal Transport
- (ii) Personnel service centres like Labour office or Labour Bureau, Canteen, etc.
- (iii) Plant maintenance centres such as Tool Room, Carpenter Shop, Smithy etc.
- (iv) Administration centres e.g. General Offices, Accounts Office, Cash Section

Cost Centres serve the following two main purposes. —

- (i) They delineate spheres of responsibility. The manager in charge of a cost centre is assigned the responsibility for the control of costs of that centre. It is because of the controlling function of costs with relation to cost centres that the latter are often termed as 'Responsibility Centres'.
- (ii) Cost centres are meant to ascertain where recovery area, all costs for which a centre is responsible very can be reasonably used. For example, a machine or group of machines performing the same functions may be connected into an equipment type of cost centre. Such a cost centre would form a complete group for the recovery of overhead costs on the basis of machine hours.

The number of cost centres and the size of each vary from one undertaking to another and are decided upon the expenditure involved and the requirements of the management for the purpose of cost control. Too many cost centres tend to be expensive but having too few cost centres defeats the very purpose of control.

Personal cost centres generally follow the organisational pattern of the concern. Costs may be analysed and related to, say, the Works or Production manager, Sales manager, Finance manager or further down, to the Foreman, Storekeeper, Inspector, Maintenance engineer etc.

There are two other types of cost centres, namely, Operation and Process Cost Centres. Operation Cost Centres consist of those machines and/or persons which carry out similar operations, and Process Cost Centres consist of those engaged on a specific process or a continuous sequence of operations. In an operation cost centre, all machines or all operatives performing the same operation are brought together under one centre, the purpose being to ascertain the cost of each operation irrespective of its location inside the factory. In the process type cost centre, the cost is analysed and related to a series of operations in sequence such as in chemical industries, refineries, steel rolling etc.

While cost centres help in ascertaining costs by location, person, equipment, operation or process, *cost unit* is a device for the purpose of breaking up or separating costs into smaller subdivisions attributable to products or services. It is the unit of quantity of product, service, or time (or combination of these) in relation to which costs may be ascertained or expressed. We may, for instance, determine the cost per tonne of steel, per tonne-kilometre of a transport service or per hour. Sometimes, a single order or contract constitutes a cost unit.

unit which is known as a job. A batch which consists of a group of identical items and maintains its identity through one or more stages of production may also be taken as a cost unit.

The forms of measurement used as cost units are usually the units of physical measurement like number, weight, area, volume, length, time and value. A few typical examples of cost units are given below

<i>Industry or product</i>	<i>Cost Unit basis</i>
Automobile	Number
Cable	Metre or kilometre
Cement	Tonne
Chemicals	Litre, kilogram, tonne
Gas	Cubic metre
Metal plating	Square metre
Mines and Quarries	Tonne
Nuts and Bolts	Gross or bags of standard weight
Power (Electricity)	Kilo-watt hour
Steel	Tonne
Traffic	Tonne-kilometre, passenger-kilometre

The selection of suitable cost centres or cost units for which costs are to be ascertained in an undertaking depends upon a number of factors some of which are :

~~1. Location of the factory.~~

- (i) Conditions of the factory.
- (ii) Requirements of the costing system, i.e. suitability of the units or centres for a purpose
- (iii) Availability of information.
- (iv) Management policy regarding making a particular choice from several alternatives

Profit Centre. *Profit centre* is a segment of a business that is responsible for all activities involved in the production and sales of products, systems and services. Thus a profit centre encompasses both costs that it incurs and revenue that it generates. In the concept of responsibility accounting, profit centres are sometimes also responsible for the investment made for the centre ; the profit is related to the invested capital. Such a profit centre may also be termed *investment centre*.

Cost Objective. Many accountants use the term cost objective to denote any activity for which costs are required to be determined separately. A standard definition specifies cost objective as 'a function, organisational sub-division, contract or other work unit for which cost data are required and for which provision is made to accumulate and measure the cost of processes, products, jobs, capitalised projects and so forth.' Thus cost objective covers both cost centre and cost unit and a cost objective may be a department, a product, a sales territory, passenger mile, patients in a hospital, books in a library—as a matter of fact 'anything' for which cost is desired to be determined.

Methods of Costing and Types of Costs. Several methods or types of costing have been designed to suit the needs of individual business conditions. The

basic principles underlying all these methods are the same, namely, to collect and analyse the expenditure according to the elements of costs and to determine the cost for each cost centre and or cost unit. The main consideration which applies to the choice of a particular method of costing is the nature of the manufacturing operation carried out or the service rendered by the concern.

The various methods of costing in use have been listed here. Detailed discussions of the methods follow in subsequent chapters. Basically, there are two main systems of costing, viz. Job Costing and Process Costing and all other types are either variants of these two systems or are just techniques used for particular purposes, under special conditions and on specific occasions.

1. Classification of cost methods on the basis of nature of production or manufacturing process

(a) Job Costing

Variations of job costing are

- (i) Batch Costing
- (ii) Terminal or Contract Costing
- (iii) Multiple or Composite Costing

(b) Process Costing

Variations of process costing are

- (i) Operation Costing
- (ii) Single or Output Costing
- (iii) Operating Cost

2. Classification of costs on the basis of time

(a) Historical Costs

(b) Pre-determined Costs

- (i) Estimated Costing
- (ii) Standard Costing

3. Costs for managerial decision making

- (i) Marginal Costing
- (ii) Incremental (or differential) Costs
- (iii) Uniform Costing
- (iv) Opportunity Costs
- (v) Replacement Cost
- (vi) Sunk Costs
- (vii) Relevant Costs

4. Costs according to functions

A business enterprise performs a number of functions like manufacturing, administration, selling, distribution, and research. Costs may be required to be determined for each of these functions and on this basis, functional costs may be classified into the following types. (Costs classified under items (ii), (iii), (iv) and (v) are also termed, 'non-manufacturing costs'.)

- (i) Manufacturing or Production Costs
- (ii) Administration Costs
- (iii) Selling and Distribution Costs

(iv) *Research and Development Costs*

(v) *Pre-production Costs*

5. *Classification of costs on the basis of their variability in relation to output*

(i) *Fixed Costs*

(ii) *Variable Costs*

(iii) *Semi-variable or Semi-fixed Costs*

6. *Classification of costs based on establishment of relationship between input and output*

(i) *Engineered Costs*

(ii) *Managed Costs, discretionary or programmed costs*

7. *Controllable and uncontrollable costs*

8. *Other types of costs*

Costs which arise in particular contexts and which are used for particular purposes are mentioned below

(i) *Conversion Cost*

(ii) *Common Costs*

(iii) *Traceable Cost*

(iv) *Joint Costs*

(v) *Avoidable Costs*

(vi) *Unavoidable Costs*

(vii) *Total Cost*

It would thus be seen that different costs are needed for different purposes. In order to make management accounting effective, it is essential that the proper concept of cost be selected that would suit the purpose for which cost data are required. Cost data not appropriate to a situation and a cost concept used in wrong context often lead to incorrect decisions.

Cost Control. The essential features of cost accounting are : determination of costs, planning and control of costs, cost analysis and furnishing of information to management for decision making, and cost reduction. It would be seen that the main objective is cost control and the determination of costs, and cost reporting are just tools or means to achieve effective cost control.

Cost control is defined as the regulation by executive action of the costs of operating an undertaking, particularly where such action is guided by cost accounting. Cost control is exercised through numerous techniques some of which are Standard Costing, Budgetary Control, Estimated Costing, Inventory Control, Quality Control and Performance evaluation, analysis and reporting.

Cost control involves the following steps and covers various facets of management (indicated in brackets) :

1. The first step is to establish the plan. The plans or targets may be in the form of budgets, standards, estimates or even past actuals and may be expressed in physical as well as monetary terms. These serve as yardsticks by which the planned objective can be assessed quantitatively. (*Planning*)

2. The plan and the policy laid down by the management are made known to all those responsible for carrying them out. Communication is established in

two directions, directives are issued by higher level management to the lower level for compliance and the lower level executives report performances to the higher level (*Communication*)

3 The plan is given effect to and performance starts. The performance is evaluated, costs are ascertained and information about results achieved are collected and reported. The fact that costs are being compiled for measuring performances acts as a motivating force and makes individuals endeavour to better their performances (*Motivation*)

4 The actual performance is compared with the pre-determined plan and variances, i.e. deviations from the plan are analysed as to their causes. The variances are reported to the proper level of management (*Appraisal and reporting*)

5 The variances are reviewed and decisions taken. Corrective action and remedial measures, or revision of the target, as required, are taken (*Decision making*)

For the success of a cost control system, it is essential that physical control should be exercised on the shop-floor by those who are entrusted with the actual incurring of expenditure either in the form of cash or in the utilization of labour, material and other resources. Control in terms of cost is remote and historic because of the time-lag between the incurrence of cost and its recognition. On-the-spot control over consumption of materials and utilization of labour and machine time is a direct form of control carried out at the point where costs are incurred. The shop foreman keeps an eye on the target set for his shop in physical terms, e.g. labour hours, machine hours, and quantities of material, waste, and spoilage before he actually proceeds to incur expenditure.

Control of labour cost is relatively simpler. The standard or estimated time required for an operation and the trade and grade of the worker who would perform it are laid down after careful work study. The actual time taken for the operation is recorded and variances from the standard time as also any deviation in the actual employment of the specified trade and grade of labour are highlighted. Material cost may be controlled in a similar manner. Standards or estimates of direct material requirements of a job are established both in quantity and price and the actual consumption is compared with the standard. While quantity control may be exercised by the shop foreman who draws the material for consumption in production, price is mainly controlled by the purchase department at the stage when orders are placed on suppliers. Overhead may be controlled through budgets established in terms of costs for each item and for each shop. Many of the items of overhead costs like power, maintenance, overtime, shift work, and idle time may also be budgeted in physical units to enable immediate control being exercised in the shops.

The advantages of cost control are mainly as follows —

1. Achieving the expected return on capital employed by maximising or optimising profit
2. Increase in productivity of the available resources
3. Reasonable price for the customers
4. Continued employment and job opportunity for the workers.

5. Economic use of limited resources of production.
6. Increased credit-worthiness.
7. Prosperity and economic stability of the industry.

Advantages of Cost Accounting. Cost accounting has manifold advantages, a summary of which is given below. It is not suggested that having installed a system of cost accounting, a concern will expect to derive all the benefits stated here. The nature and the extent of the advantages obtained will depend upon the type, adequacy and efficiency of the cost system installed and the extent to which the various levels of management are prepared to accept and act upon the advice rendered by the cost system.

(i) A cost system reveals unprofitable activities, losses or inefficiencies occurring in any form such as :

- (a) wastage of man power, idle time and lost time,
- (b) wastage of material in the form of spoilage, excessive scrap etc., and
- (c) wastage of resources, e.g. inadequate utilization of plant, machinery and other facilities.

(ii) Cost accounting locates the causes for decrease or increase in the profits of the business. It reveals unprofitable products or product lines so that these may be eliminated or alternative measures may be taken. Cost data enable the correct assessment of the profitability of an existing business or a new project to be undertaken. This is useful not only for the management but also for the prospective creditors and lending and financing institutions.

(iii) Cost accounts furnish suitable data and information to the management to serve as guides in making decisions involving financial considerations. Guidance may be given by the cost accountant on a host of problems such as whether to purchase or manufacture a given component, whether to accept orders below cost, which machine to purchase in a situation where a number of choices is available, and so on.

(iv) Cost accounting is useful for price fixation purposes. Although selling price is generally related more to economic conditions prevailing in the market than to cost, the latter serves as a guide to test the adequacy of selling prices. Further, while quoting prices to prospective customers or filing tenders, the cost accountant assists in the preparation of estimates of anticipated or 'would be' costs of the products to be manufactured to meet the order.

(v) With the application of standard costing and budgetary control methods, the optimum level of efficiency is set. Variance analysis points out the deviations from this level so that suitable measures can be taken for plugging weak points. 'Management by exception', which is based on the principle of concentrating action only on variances leaving out the items which conform to the norm, saves a lot of time, effort and expenditure on the part of the management.

(vi) Cost comparison helps in cost control. Comparison may be made from period to period, of the figures in respect of the same unit or factory or of several units in an industry by employing uniform costs and inter-firm comparison

methods Comparison may be made in respect of costs of jobs, processes or cost centres

(vii) A cost system provides ready figures for use by the Government, wage tribunals and boards, and labour and trade unions for application to problems like price fixation, price control, tariff protection, wage level fixation, payment of dividends, or settlement of disputes

(viii) When a concern is not working to full capacity due to various reasons such as shortage of demands or bottlenecks in production, the cost of idle capacity can be readily worked out and revealed to the management

(ix) Introduction of a cost reduction programme combined with operations research and value analysis techniques leads to economy. There is a continuous all-round effort towards finding out new and improved methods in order to reduce costs

(x) Marginal costing is employed for suggesting courses of action to be taken. It is a useful tool for the management for making short-term decisions. The effectiveness of marginal cost technique becomes more apparent in times of trade depression when orders may have to be accepted at a price lower than the total cost

(xi) Determination of ~~cost centres or responsibilities~~ needs of a cost accounting system ensures that the organisational structure, the concern has been properly laid out. Responsibilities can be properly defined and fixed on individuals

(xii) Perpetual inventory system which includes a procedure for continuous stock taking is an essential feature of a cost system. This is of importance for exercising inventory control and at the same time it facilitates the preparation of periodical profit and loss accounts

(xiii) The operation of a system of cost audit in the organisation prevents manipulation and fraud and assists in furnishing correct and reliable cost data to the management as well as to outside parties like the shareholders, the consumers and the Government

(xiv) Costs of the closing stock of raw materials, work-in-progress and finished products can be easily obtained from cost records to prepare Profit and Loss Account on a realistic basis

Installation of a Cost System. From what has been stated in the preceding sections, it will be seen that there cannot be a ready-made cost system suitable for a business. Such a system has to be specially designed for an undertaking to meet its specific needs. Before installing a cost system, proper care should be taken to study and take into account all the aspects involved as otherwise, the system will be a misfit and full advantage will not be derived from it

The following points should be looked into and the prerequisites satisfied before installing a cost system

- (i) The nature, method and stages of production, the number of varieties and the quantity of each product and such other technical aspects should be examined. It is to be seen how complex or how simple the

production methods are and what is the degree of control exercised over them

- (ii) The size, layout and organisation of the factory should be studied
- (iii) The methods of purchase, receipt, storage and issue of materials should be examined and modified wherever considered necessary
- (iv) The wage payment methods should be studied.
- (v) The requirements of the management and the policy adopted by them towards cost control should be kept in view
- (vi) The cost of the system to be installed should be considered. It is needless to emphasize that the installation and operation of the system should be economic
- (vii) The system should be simple and easy to operate
- (viii) The system can be efficiently run if it is appropriate and properly suited to the organisation
- (ix) Forms and records of original entry should be so designed as to involve minimum clerical work and expenditure
- (x) The system should be so designed that cost control can be effectively exercised
- (xi) The system should incorporate suitable procedure for reporting to the various levels of management. This should be based on the

Principles of exception

criticism is sometimes "levelled" against the efficacy of cost accounting systems. This arises mostly when the system has not been properly planned and executed. If a cost system is properly installed so that the advantages accruing from it outweigh the cost of installation and operation, there is no reason why it should fail to render effective and valuable assistance to the management. The difficulties likely to arise and the methods to overcome them are summarised below.

- (i) Expense of installation and operation. The cost of installation and operation of a cost system may sometimes be high.
- (ii) The cost system selected may not be suitable for the business.

The above mentioned difficulties are not due to the fault of the cost accounting principles but they arise on account of installation of a badly conceived system. Proper re-designing and tuning up of the system can easily overcome these difficulties.

- (iii) Employees' resistance to the installation of a system.

Such resistances which arise due to ignorance and suspicion, are common to all systems, whenever new methods or procedures are proposed to be introduced in a business. Proper education of the employees to impress upon them the advantages of the system and the importance of the role they have to play in it should normally set matters right.

Limitations of Cost Accountancy. Like any other system of accounting, Cost Accountancy is not an exact science but an art which has developed through theories and accounting practices based on reasoning and keen common sense. Many of the theories cannot be proved nor can they be disproved, they have grown in course of time to become conventions and accepted principles of cost accounting. These principles are by no means static, they are changing from

day to day and what is correct today may not hold true in the circumstances tomorrow

No costs can be said to be exact as they incorporate a large number of conventions, estimations and flexible factors such as

- (i) classification of cost into its elements
- (ii) materials issue pricing based on average or standard costs,
- (iii) apportionment of overhead expenses and their allocation to cost centres or cost units
- (iv) arbitrary allocation of joint costs,
- (v) division of overheads into fixed and variable
- (vi) allocation of distribution and direct material costs in the absence of correct and complete data, and
- (vii) adoption of standard costs and marginal costs

Thus when a cost accountant presents cost data, he does not necessarily present absolutely 'true' costs. What he tells us to be the cost is actually a congregation of data some of which have been allocated, some apportioned, some estimated or predicted and a few suitably modified in the light of conventions and according to the judgement and opinion of the cost accountant. Cost divergence also occurs in different units in the same industry because of different policies followed with regard to the inclusion or non-inclusion of certain items of expense, pricing of materials, overhead apportion etc.

No one cost is suitable for all purposes in all circumstances. Computation and presentation of a particular cost depends upon the use to which the cost data are required to be put to. For example, standard costs would be different from the so called actual costs, and costs for pricing in periods of recession would be entirely different from those intended for pricing in normal conditions. To the unwary management all the may seem confusion.

Accuracy in cost accounting is relative. Certain presumptions are always made while determining cost to suit a particular situation and as these presumptions are largely a matter of personal opinion, costs prepared by two accountants may not always be identical.

EXAMINATION QUESTIONS

- 1 'Accountancy is a profession, the great majority of whose members still produce stewardship accounts which are necessary elements of commercial probity, but have no constructive bearing on economic advancement'. Do you agree that the above description fits Cost Accountancy just as well? Discuss fully. (I C W A, Final)
- 2 'Comparison is the foundation of modern Managerial control'. Comment. (I C W A, Inter)
- 3 'A sound costing system must place the same emphasis on cost control as on cost ascertainment'. Comment on the statement. (I C W A, Inter)
- 4 An existing cost system lacks the essential aspects of cost control. List the main matters to be introduced to make good the system's deficiencies. (I C M A, Final)

- 5 Detail five of the particular aims and objects sought to be achieved by the introduction of a cost accounting system in a factory having products for sale to public through retailists' lists. (M Com C U)
- 6 Costing is generally considered as a tool in the hand of the accountant. Do you concur? Discuss the influence of this view upon the offer of cost accounting to organisations like banks, fire and insurance companies, and future holders of shares to the general public. (I C W 4 Final)
- 7 You have been asked to install a costing system in a unit manufacturing shoes. Apart from technical costing problems, what practical difficulties would you expect to meet and how would you propose to obviate or overcome them? (I C W 4 Inter)
- 8 You have been requested to install a cost accounting system in a factory manufacturing a single product, the specification of which are of course modified to suit the requirements of individual customers. It is said that the cost may be a ready-made cost system suitable for a business and for a ready-made system suitable for the organisation.
Before proceeding to install a system, state the preliminary examinations you would make and what are the points which you would bear in mind to keep in view the oft mentioned apprehension of the industrialists that cost systems are too costly for them to install? (I C W 4 Final)
- 9 What are the general principles which you, as a cost accountant, should keep in mind while installing a costing system? (I C W 4 Final)

CHAPTER 2

MATERIAL COSTS

Materials constitute one of the important factors of production in a business. The term 'materials' refers to the commodities supplied to an undertaking for the purpose of consumption in the process of manufacture or of rendering service or for transformation into products. The costs of all such materials form part of the cost of jobs, operations, products, or services for which they are utilized.

The term 'stores' is often used synonymously with materials. The former has, however, a wider meaning and it covers not only the raw materials consumed or utilized in production but also such other items as sundry supplies, maintenance stores, fabricated parts, components, tools, jigs, fixtures and other equipments. Finished and partly finished products are also often included under the term 'stores'. Mention may also be made of the commonly used term, 'inventory' which covers the stock not only of raw materials but also components, work-in-progress and finished stock.

The procedure followed in a manufacturing concern in respect of materials is broadly, to procure materials, ~~use them till such time as required and then~~ use them for consumption in manufacture. ~~to prevent theft, deterioration, and wastage, physical controls of numerous kinds are available. But~~ simultaneously, proper controls are absolutely necessary to avoid extra expenditure, (a) of purchases in excess of needs, (b) of slowing down production due to non-availability of stores, and (c) through improper use of material intentionally or otherwise. The system of control should be comprehensive enough to cover the flow of materials starting from the point when someone in the organisation makes a request for purchase up to the stage when the materials are consumed and their costs are compiled and assembled in Cost Sheets.

Requisites of a Materials Control System. The main requirements of an efficient system of materials control are as follows : -

- (i) Co-ordination and co-operation between the various departments concerned, viz. Purchase, Receiving, Inspection, Storage, Issues, and Accounts and Cost Departments.
- (ii) Use of standard forms and documents in all the stages of control.
- (iii) Classification, codification, standardisation, and simplification of materials.
- (iv) Planning of requirement of materials and scheduling of deliveries.
- (v) Efficient purchase organisation.
- (vi) Budgetary control of purchases.
- (vii) Planned storage of materials ; physical control as well as efficient book control through satisfactory storage control procedures, forms, and documents.
- (viii) Appropriate records to control issues and utilisation of stores in production.
- (ix) Efficient system of internal audit and internal checks.

- (x) System of reporting to management regarding material purchase, storage, and utilization.

It follows that a properly drawn out system of materials control would bring forth the advantages enumerated above.

Materials Control Routine. The routine for a system of materials control may be summarised as follows, the various steps having been arranged in the sequence in which they occur :

- (a) Request for purchase of materials ,
- (b) Inquiry and tender forms issued to prospective suppliers ;
- (c) Receipt of quotations from suppliers and selecting the suitable supplier ;
- (d) Purchase action ;
- (e) Receipt of materials and inspection ,
- (f) Transactions with suppliers, e.g. payment of bills, issue of debit or credit notes etc. ;
- (g) Bringing materials on charge and storage ,
- (h) Issue of materials.

Within the framework of the above broad outlines, the practice followed 'different concerns vary, particularly with regard to the detailed records ~~on matters of documents made out, etc.~~ The procedures ~~assessed in this chapter may, therefore, be taken as a representative one that will~~ be found most suitable for medium or large size firms.

Purchase Control. Purchasing of stores is primarily a function of the management. Nevertheless, it forms an important aspect of materials control and as such the cost accountant should be closely associated with the system of purchase in the undertaking. He can render assistance to the Purchase Department by presenting data and information on the following aspects :—

- (i) Effects of over-stocking on costs.
- (ii) Reports on redundant, obsolete, dormant, surplus and slow-moving stores.
- (iii) Effect on cost of a weak or strong purchase organization.
- (iv) Economic buying vis-a-vis cost of production.
- (v) Reports on costs of substitute materials, or materials of differing qualities and grades. (Use of inferior material may reduce material price but may result in more consumption of material and sometimes, more labour cost).
- (vi) Comparative costs relating to problems of purchase of special items or taking decision whether to purchase an item or manufacture it in the factory.
- (vii) Effect of changes in material prices on standard material cost, price quotations and valuation of stock.

Much of the success of a business depends upon the efficiency of its purchase organisation. The *advantages* of having an efficient Purchase department and for that matter, a good and adequate system of purchase control are as follows :—

- (i) Purchase of material of proper quality and specification obviates waste of materials and loss in production,

- (ii) Purchases are made at the proper time so that the advantages of a favourable market can be taken
- (iii) Purchase of the requisite quantity of materials avoids locking up of working capital. At the same time it ensures that sufficient material is always available so that there are no production delays. The risk of surplus, obsolete and deteriorated stores is minimised
- (iv) Purchase from the best market and from reliable suppliers improves business relations and makes available the best terms of supply and favourable delivery dates
- (v) Adoption of the most advantageous method of purchase and proper drafting of purchase agreements and contracts eliminate the risks of any disputes or financial loss
- (vi) Purchases are made at the most economical price. This results in reduction of material costs

Purchase Department Organisation. The organisation of the purchase department depends upon the size of the purchase it is required to handle. The general principle is that the purchase department should be centralized under the control of a Purchaser or Chief Purchaser who ranks level with the top management. Even where several factories are under the management of one undertaking, the purchase department should be placed under one individual and material should be purchased centrally as far as possible. In some cases, where the value is limited, value may be authorised for local purchase by individual factories. Though slightly expensive due to increase in administration costs, centralized purchasing has the advantage of low price and uniform quality, buying on favourable terms, economy in recording and accounting, availability of specialised buying staff, reduction of stock, and elimination of surplus stores.

Qualifications of a Purchaser. An efficient Purchaser should have the following qualities:

- (i) He should have an intimate knowledge of the materials that he is required to purchase, and their specifications, quality and quantity
- (ii) He should be aware of the policy of the management and the financial resources of the business and their impact on purchases
- (iii) He should be aware of the market conditions and should have a complete knowledge of the market, sources of supply, reliable suppliers, routes of supply, price and purchasing formalities
- (iv) He should maintain proper records and documents like catalogues, price lists, trade magazines, and journals to assist him in locating the best market
- (v) He should have up-to-date knowledge of government policies regarding import and export restrictions and various duties and taxes on commodities
- (vi) He should be well conversant with economic principles of demand and supply, price etc
- (vii) He should have a working knowledge of laws relating to contracts and sale of goods so that he may be able to negotiate and enter into contracts on suitable terms for purchase of materials
- (viii) He should be a man of high integrity

Purchase Requisition. The purchase department does not on its own initiate any action for purchase of materials. This action is taken either by the store-keeper for items of materials required for regular production purposes, or by the production department or production planning department for purchase of special items not normally stocked. For instance, requests for the purchase of special maintenance materials may be made by the maintenance department and action for initiating purchase of office stationery and equipments may be taken by the office manager.

Requests for purchases are made to the purchase department on a form known as Purchase Requisition. It will be seen from the form of the purchase requisition (Fig 2.1) that it provides for three basic informations which assist in the work of the purchase department. These are

- What material is to be purchased (*purchase of right quality*),
- When it is to be purchased (*purchase at right time*), and
- How much is to be purchased (*purchase of right quantity*)

(The procedure of calling for tenders and placing purchase orders, discussed later, ensures *purchase at right price* and *purchase from right source*.)

The purchase requisition is usually prepared in triplicate, one copy is retained in the indenting department for office record and two copies are sent to the purchase department where one copy is retained and the other returned to the indenting department containing therein the details of the order placed. This serves the purpose of confirmation that a purchase requisition has been taken.

PURCHASE REQUISITION			
From _____	Department _____	No _____	
To Purchase Department		Date _____	
Please take action to purchase the following material which is required on _____ for utilization against _____ (ID No) _____			
Production order No _____	_____	for Stock _____	
Service order No _____			
Particulars of material	Code No	Unit of quantity	Quantity
Signature _____			
(To be filled in by the Purchase Department)			
Purchase Order No _____			
Supplier _____			

Fig. 2.1. Purchase Requisition

No book keeping entries, either in the financial or cost records are necessary for the purchase action starting from requisitioning up to the placing of a purchase order. The storekeeper may, however, make entries in the memorandum column of the stores ledger or in the bin cards to the effect that requisitions have been issued and/or orders placed for supply.

Specification and Quality of Materials (What to Purchase). The particulars and specifications of the materials to be purchased are indicated in the purchase requisition. Usually, only one item of material is requisitioned on one requisition form. The details given should be mentioned clearly so as not to leave any room for ambiguity. Any difficulty or mistake on the part of the purchaser in interpreting the information conveyed in the requisition regarding the specifications of a material may result in a faulty purchase. It is likely that in such cases a material quite different from what was actually intended may be purchased.

Exactitude in specifying the particulars can be achieved by a proper system of classification to cover all types of materials handled in the business. The classification may also be supplemented by a system of symbols or codes for materials.

Classification also assists in ensuring purchase of the requisite quality materials. Generally, no goods are accepted nor payments made for the same till the materials are tested and ~~received after inspection.~~ In the case of proprietary items which are the monopoly of the suppliers and in case of established brands of materials, testing or inspection is not of significance since the qualities of such materials are already specified. In other cases, quality may be determined on the basis of standard specifications, physical and chemical properties etc. The standards laid down by the *Indian Standards Institution* in respect of a number of raw materials used in the industries may also be helpful. Where the quality of a material cannot be properly defined, it is advisable to purchase it from reliable suppliers.

Time of Purchase (When to Purchase) The purchase requisition indicates two dates, viz. the date of issue of the requisition and the date by which delivery is expected. For items of materials which are regularly used, the storekeeper places a requisition as soon as the ordering level is reached. The date of delivery is specified keeping in view the rate of consumption of the material and the minimum level fixed for it.

Special items for which no level would ordinarily be fixed are purchased against the estimated requirement for meeting the production programme. The time when delivery is required is determined by the production department or planning department.

Purchase is also often made when the market is favourable. This is done without regard to the immediate requirements of production and not in accordance with the normal purchase plan. For example, when the price of a material is rising or when a material is likely to be in short supply, it is advantageous to go in for immediate purchase. Where the raw material is a seasonal crop like cotton, jute, or sugarcane, bulk purchases are made in the season—the stock for the whole year may be purchased at a time to take advantage of quality, quantity and price. Sometimes long-term contracts, known as *rate contract*, may be entered

into with the suppliers for the purchase of materials for a specified period at a specified rate. This acts as a safeguard against fluctuation in prices which may occur during the period of supply.

Purchase Quantity (How much to purchase). Another important requirement for an efficient system of purchase control is to ensure that only the correct quantity of stores is purchased. Three basic factors are kept in view, viz.

- (a) There should be no over stocking.
- (b) Materials should always be available in sufficient quantity to meet the requirements of production and to avoid plant shut down.
- (c) Purchases should be made in economic lots.

Purchase and stocking of materials in quantities in excess of the normal requirements of a concern has the following disadvantages :—

- (i) Working capital is locked up involving cost of carrying inventory such as interest, rent etc.
- (ii) With the passage of time, there is risk of loss due to depreciation in quantity, deterioration in quality, and obsolescence of the materials during storage.
- (iii) Avoidable expenditure is incurred on handling and upkeep of surplus materials. Moreover, certain materials do not lend themselves to ~~easy handling and~~ ~~easy handling and~~ and special care is to be taken for them involving further expenditure.
- (iv) Financial loss is incurred if there is a subsequent fall in the price of materials.
- (v) More storage space is required.
- (vi) Extra insurance expenditure is to be incurred to cover losses due to fire or theft.
- (vii) Risk of breakage, pilferage, and excessive consumption is increased.

On the other hand, keeping stock of materials down to such a limit that the requirements cannot be met is equally injudicious. The following contingencies may arise :

- (i) If raw materials fall short of requirements, supplies have to be rushed by frantic purchases at whatever price they are available, if stoppage of production is to be avoided or a plant break down is to be set right. The stock-out cost of an important spare part may be many times the actual purchase cost of the part.
- (ii) If material of required quality is not available at the moment, a costlier substitute from existing stock may have to be issued.
- (iii) Production schedules are upset and output falls resulting in rise in costs, decrease in profit and sometimes, payment of damages to customers.
- (iv) Where several operations or processes are linked together, stoppage of work in a department creates a bottleneck as the next department or process in the sequence may also have to wait for work.
- (v) Payment of idle time to workers may be involved.
- (vi) If target dates of production are to be kept, the short-fall may have to be met later by working overtime causing further increase in costs.

To ensure that the optimum quantity of materials—neither less nor more—is purchased and stocked, scientific methods of inventory management are available. Even where sophisticated techniques are not in use, the common practice is to fix certain levels for each item of materials. These are discussed in the next section.

Before taking a final decision regarding the quantity to be purchased, the following additional factors are kept in view :—

- (i) *Quantity already on order* : If an order has been placed earlier for the same material, the quantity to be purchased on the current order is suitably reduced.
- (ii) *Quantity reserved* : The material earmarked for any particular job is excluded from the stock in hand in order to arrive at the quantity to be purchased. When stock piling is done whereby deliberate purchase of quantities much in excess of current requirements is made, the quantity kept aside as reserve is not taken into account in any of the calculations. Alternatively, all the levels maximum, minimum and re-ordering are increased to the extent of the quantity in reserve.
- (iii) *Availability of funds* : Most business concerns have a system of financial budgeting. Allotment of funds for various types of purchases are made and included in the monthly budget. Before making a purchase, the amount already spent and the commitments made are checked against the allotment to find out whether funds exist for the purchase.

Levels of Materials. The various stock levels fixed for effective material control are Maximum Level, Minimum Level, Ordering or Re-ordering Level and Danger Level. These levels serve as indices for initiating action on time so that the quantity of each item of material, i.e. the inventory holding is controlled. It should be noted that these levels are not fixed on a permanent basis but are liable to revision in accordance with the changes in the factors determining the levels.

Maximum Level. The maximum level indicates the maximum quantity of an item of material that can be held in stock at any time. The stock in hand is regulated in such a manner that normally, it does not exceed this level. While fixing the level, the following factors are to be taken into consideration :—

- (i) Maximum requirement of the store for production purpose, at any point of time.
- (ii) Rate of consumption and the re-order period, i.e. lead time.
- (iii) Nature and properties of the store : For instance, the maximum level is necessarily kept low for materials that are liable to quick deterioration or obsolescence during storage.
- (iv) Storage facilities that can be conveniently spared for the item without detriment to the requirements of other items of stores.
- (v) Cost of storage and insurance.
- (vi) Economy in prices : For seasonal supplies purchased in bulk during the season, the maximum level is generally high.

- (vii) Financial considerations Availability of funds and the price of the stores are to be kept in view For costly items, the maximum level should be as low as possible Another point to be considered is the future market trend If prices are likely to rise, the concern may like to resort to stock-piling for keeping large stock in reserve for longterm future use and in such a case, the level is pushed up
- (viii) Rules framed by the government for import or procurement If due to these and other cause, materials are difficult to obtain and supplies are irregular, the maximum level should be high
- (ix) The maximum level is also dependent on the economic ordering quantity

Minimum Level The minimum level indicates the lowest quantitative balance of an item of material which must be maintained in hand at all times so that there is no stoppage of production due to the material being not available In fixing the minimum level the factors stated below are considered

- (i) Nature of the item For special materials purchased against customer's specific orders no minimum level is necessary This applies to other levels also
- (ii) The maximum time (normal re-order period) required to replenish stock. This is known as the *lead time* and may be defined as the interval between the dates of issuing orders and the receipt of materials Lower the lead time, lower is the minimum level (the re-order point remaining constant)
- (iii) Rate of consumption (normal minimum or maximum) of the material

It is most likely that several of the factors stated above for fixation of maximum and minimum levels may operate at one and the same time

Ordering or Re-ordering Level When the stock in hand reaches the ordering or re-ordering level, it is an indication that action for replenishment is necessary and proposals for purchase are to be initiated This level is fixed somewhere between the maximum and minimum levels in such a manner that the quantity of stores represented by the difference between the re-ordering level and the minimum level will be sufficient to meet the demands of production till such time as the order materializes and supplies are delivered The computation of re-ordering level under various inventory systems has been discussed later in this chapter

Danger Level This is a level fixed usually below the minimum level When the stock reaches this level, very urgent action for purchase is indicated This presupposes that the minimum level contains a cushion to cover such contingencies. As the normal lead time cannot be afforded at this stage, it is necessary to resort to unorthodox hasty purchase procedure resulting in higher purchase cost.

The practice in some firms is to fix danger level below the re-ordering level but above the minimum level. In such cases, if action for purchase of an item was taken when the stock reached the re-ordering level, the danger level is of no significance except that a check with the purchase department may be made as soon as the danger level is reached to ensure that everything is all right and that delivery will be made on the scheduled date.

It will be seen that while fixation of danger level below the minimum level is

an indicator for taking corrective action, danger level fixed above the minimum level is meant for preventive action

An illustration to show the fixation of the various levels is given below :

EXAMPLE 21.

Two components A and B are used as follows —

Normal usage 50 per week each

Re-ordering quantity A 300, B 500

Maximum usage 75 per week each

Minimum usage 25 per week each

Re-ordering period A 4 to 6 weeks B 2 to 4 weeks

Calculate for each component (i) Re-ordering level (ii) Minimum level (iii) Maximum level, (iv) Average Stock level. Comment briefly on the different levels for the two components.

(I.C.M.A. Inter)

ANSWER :

Re-order level = maximum consumption × re-order period

(This takes care of the material usage during lead time so that the stock just reaches zero level when material is received)

A 6 weeks 75 units 450 units

B 4 weeks 75 units 300 units

Minimum level = Re-order level - maximum consumption × re-order period

(With normal usage, the level will not go below minimum by the time the order materialises)

A 450 units (50 × 6 weeks) - 250 units

B 300 units (50 × 4 weeks) - 150 units

Maximum level = Re-order level + maximum usage × re-order period

(The day the order quantity is received the stock level will be order quantity plus the re-order level less the minimum consumption during the lead time)

A 450 + 300 (25 × 4 weeks) = 550 units

B 300 + 500 (25 × 2 weeks) = 750 units

Average stock level = $\frac{1}{2}$ (minimum stock level + maximum stock level)

A $\frac{1}{2}$ (200 + 550) = 375 units

B $\frac{1}{2}$ (150 + 750) = 450 units

The average stock level for B is more because of the higher range between the maximum and minimum levels. Minimum level for B is lower because of lower re-ordering level. Re-order level is lower for B because re-order period is 4 weeks for B against 6 weeks for A. Maximum level is higher for B because of its higher re-order quantity.

Obviously, stock levels cannot be properly determined in the following circumstances —

- (i) Where the rate of consumption of the material is erratic
- (ii) Where the market for the material is uncertain and hence no lead time can be forecast, and
- (iii) When the material is not in common use and is required only once in a while

Scientific Inventory Management. There are three basic inventory models, viz the *Wilson formulation* or *Fixed order quantity system*, the *Replenishment system*, and the *Optional or modified replenishment system*, which may be used for controlling the stock of goods held for the purpose of future production or sales. Each of these systems or models is described by a number of related equations that take into account, (i) the storage (or carrying) cost of the inventory, (ii) the ordering (or replenishment or set up) cost, and (iii) the shortage (or stock-out or depletion) cost of back-log orders and lost sales. The solution to an inventor

management problem seeks basically, to determine how much to purchase (or produce) and how often and so, in each of the inventory models, the order quantity and the frequency of ordering are the two important elements. The other elements are the lead time and safety (or buffer) stock. An inventory problem may be *deterministic* or *probabilistic* depending upon whether the demand (or consumption), the related costs, and the lead time can be completely known in advance or whether they are uncertain.

Inventory problems are not limited only to situations of purchase and production. These may arise in various other contexts and any problem where the optimum has to be arrived at with costs associated with too much or too little may be treated as an inventory problem and the same principles as in the case of purchase and production applied to it. For example, cash held in bank or in hand involves an inventory problem in as much as too much of cash would mean that investment profits are lost (equivalent to storage cost) and too little cash would result in uncomfortable situations due to non satisfaction of liabilities (equivalent to shortage cost). Similarly, striking a balance between productive capacity in excess of requirement (storage cost) and shortage of capacity (shortage cost) involves a typical inventory problem.

(a) **Fixed order quantity system.** In this system, the re-order quantity ~~is fixed and a re order is placed for this quantity whenever the stock in hand drops to a particular level, known as the re-order point.~~ The methods of calculation of the economic ordering quantity and the determination of the re-order point (i.e., when to re-order) under this system are discussed below.

(i) **Economic (or Optimum or Standard) Ordering Quantity.** In the fixed order quantity system, the re-order quantity is the economic ordering quantity that is fixed in such a manner as to minimise the total variable cost of managing the inventory. This cost is made up of two parts, viz. the cost of ordering or acquiring and the cost of carrying or holding the inventory. While with increase in the quantity of purchase, the cost of ordering per unit decreases, the carrying cost increases. A balance is, therefore, struck between these two factors and the economic ordering quantity is the one for which the aggregate cost is the minimum. The quantity may be determined with the help of mathematical formula, graphs or tables.

Ordering cost, which is the additional cost of placing an order, is independent of the size of the order. If P be the cost of placing an order; q , the quantity ordered and U , the total annual purchase :

$$\text{Unit cost of placing an order} = \frac{P}{q}, \text{ and Annual ordering cost} = \frac{PU}{q}$$

The cost of carrying the inventory consists of (i) the costs of physical storage such as cost of space, handling and upkeep expenses, insurance, cost of obsolescence etc. and (ii) the opportunity cost of the capital blocked up (e.g., interest). If C be the unit purchase cost of an item, i , the carrying cost expressed as an annual percentage of the unit cost of purchase and q , the order quantity :

$$\text{Annual carrying cost per unit} = Ci, \text{ and Annual carrying cost} = Ci \times \frac{q}{2}$$

(Carrying costs are based on average inventory which is taken as $q/2$ based

on the assumption that the inventory decreases at a constant rate from the order quantity to zero, at which stage it is replenished by another quantity.)

Total annual cost = Annual order cost *plus* Annual carrying cost

$$\frac{PU}{q} + \frac{C_1 q}{2}$$

The particular value of q which minimises this total cost is the economic ordering quantity, Q . By taking the first derivative of the equation with respect to q and setting the result to zero (for the minimum value of the total cost, $\frac{dP}{dQ}=0$), we get,

$$\frac{dP}{dQ} = PU \left(\frac{1}{Q^2} \right) - \frac{C_1}{2} = 0, \text{ or } Q = \sqrt{\frac{2PU}{C_1}}$$

Where Q = Economic ordering quantity

U = Quantity (units) purchased in a year

P = Cost of placing an order

C = Unit cost of an item

i = Cost of carrying inventory (per cent per year)

The total number of orders per year may be derived from the above formula. This is

equal to total units per year $\div Q = \frac{U}{\sqrt{\frac{2PU}{C_1}}} = \sqrt{\frac{UC_1}{2P}}$

If interest on investment (say, $i_1\%$) and other items of carrying cost (say, i_2 per unit) are shown separately the formula will be, $Q = \sqrt{\frac{2PU}{C_1 + i_2}}$

The computation of the economic ordering quantity is illustrated in the examples given below.

EXAMPLE 2.2

From the following data obtained in respect of an item of store, calculate the optimum number of units per order (economic ordering quantity) for the item and the optimum value, in rupees, per order.

Total annual consumption 12,000 units

Unit purchase price Re. 1.00

Ordering cost Rs. 75.00 per order

Cost of carrying inventory 20% per annum

Also determine the optimum number of days' supply per order

ANSWER :

$$EOQ = \sqrt{\frac{2 \times 75 \times 12,000}{1.00 \times 0.20}} = 3,000 \text{ units ; Value } 3,000 \times \text{Re. } 1.00 = \text{Rs. } 3,000$$

[If 3,000 units are ordered, the cost will be :

Ordering cost (4 orders) — Rs. 300

Carrying cost (Average inventory, $q/2 = 1,500$) Rs. 300

Total inventory managing cost Rs. 600]

The optimum number of days' supply per order may be computed as $n/(\text{Number of orders per year}) = n/\sqrt{\frac{UC_1}{2P}}$, where n is the number of days in a year

$$\text{Here, this will be equal to } 360/\sqrt{\frac{12,000 \times 1.00 \times 0.20}{2 \times 75}} = 360/4 = 90 \text{ days}$$

EXAMPLE 2.3.

A manufacturer buys certain equipment from outside suppliers at Rs. 30 per unit. Total annual needs are 800 units.

The following further data are available :

Annual return on investment, 10%

Rent, insurance, taxes per unit per year, Re. 1

Cost of placing an order, Rs. 100

Determine the economic order quantity and the number of orders to be placed per year.

(C. U. M. Com—Adapted)

ANSWER :

Cost of carrying inventory per unit = $30 \times 10\% + 1$

$$F.O.Q. = \sqrt{\frac{2 \times 100 \times 800}{30 \times 10\% + 1}} = 200 \text{ units, Number of orders per year } \frac{800}{200} = 4$$

The ordering cost, the carrying cost and the cost of inventory management may be illustrated graphically as in Fig. 2.2. The figures from Example 2.2 have been taken. It will be seen that the annual ordering cost decreases with increasing order quantity and the carrying cost increases in proportion to the increase in the order quantity. The total annual cost of inventory management decreases progressively up to a certain point, i.e. up to the economic order quantity and thereafter shows an increase with increasing order quantity.

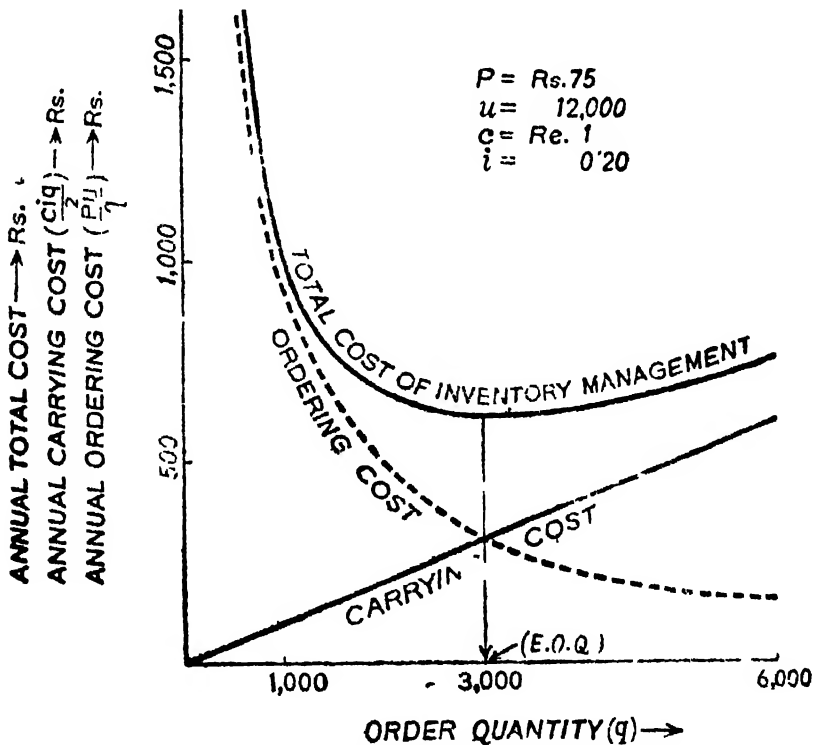


Fig. 2.2. Economic Ordering Quantity

When purchase price is varying with the quantity purchased, the tabular method or the trial and error method of determining the economic order quantity is more suitable, as illustrated in Example 2.4.

EXAMPLE 2.4

A firm is able to obtain quantity discounts on its orders of material as follows : -

Price per tonne

Tonnes

Rs	
6.0	less than 250
5.9	250 and less than 800
5.8	800 and less than 2,000
5.7	2,000 and less than 4,000
5.6	4,000 and over

The annual demand for the material is 4,000 tonnes

Stock holding costs are 10% of material cost per annum

The delivery cost per order is Rs 6.00

You are required to calculate the best quantity to order

(I.C.M.A., Pt. IV Adapted)

ANSWER :

Using the tabular method, the total costs per annum for different values of the ordering quantity are

Ordering quantity Q	Price per tonne C	Cost of Purchase $U \times C$	Cost of Order $\frac{Q}{2} \times 6$	Cost of Stock holding $\frac{Q}{2} \times 10\% \times C$	Total Cost (4) + (3) + (5) Rs
(1)	(2)	(3)	(4)	(5)	(6)
	Rs	Ks	Rs	Rs	Rs
200	6.0	4,000 6.0	$\frac{4,000}{200} \times 6$ 120	$\frac{200 \times 2 \times 6}{2}$ 120	24,240.00
250	5.9	4,000 5.9	$\frac{4,000}{250} \times 6$ 96	$\frac{250 \times 2 \times 5.9}{2}$ 147.50	23,543.50
800	5.8	4,000 5.8	$\frac{4,000}{800} \times 6$ 30	$\frac{800 \times 2 \times 5.8}{2}$ 464	23,694.00
2,000	5.7	4,000 5.7	$\frac{4,000}{2,000} \times 6$ 12	$\frac{2,000 \times 2 \times 5.7}{2}$ 1,140	23,952.00

The minimum cost is Rs 23,694 when the ordering quantity is 800 tonnes. The latter is, therefore, the optimum ordering quantity.

(ii) **Re-order point** At re-order point, the level of stock is equal to the average expected consumption (or sales) of the item during the lead time, the idea being that till the time the purchase order materialises, there is sufficient stock to meet the demand. The actual consumption during the lead time may, however, be sometimes more than the average consumption or there may be a variation in the expected lead time. In such cases, therefore, temporary stock-out occurs and so while determining the re-order point, it is necessary to add an extra buffer

stock or safety stock to the expected average consumption during the lead time to act as a protection against a possible stock-out. Thus,

Re-order point = Safety stock *plus* (average consumption per unit of time \times lead time)

$$(P = S + C \times L)$$

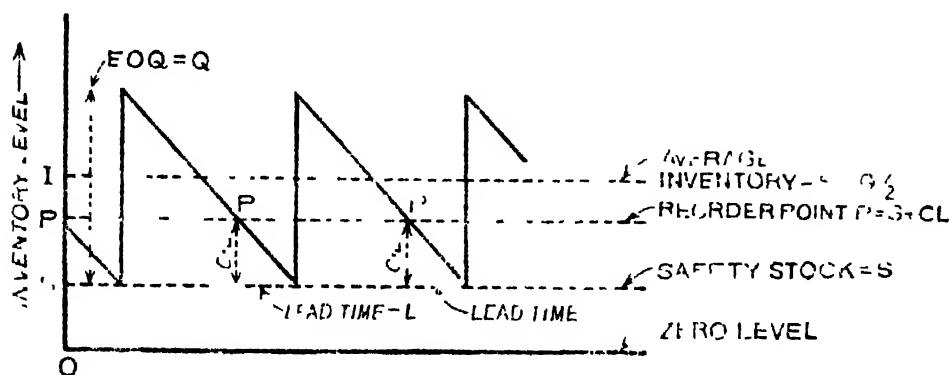


Fig. 2.3. Fixed order quantity model (uniform consumption rate)

Two inventory models, under this system, have been illustrated in Figs 2.3

In one ~~model (Fig. 2.3)~~, the rate of consumption and the lead time have both been shown to be constant so that there is no need for encroachment into the safety stock. By the time the purchase order materialises, the stock level reaches the safety stock, when fresh stock equal to the EOQ arrives. In the second illustration (Fig. 2.4), the lead time is constant but the rate of consumption has been assumed to be not uniform. Three situations have been visualized. In the first case, the consumption is at a fast rate so that by the time fresh stock arrives, some of the safety stock is used up. In the second situation, the rate of consumption is slow with the result that the stock level is above the safety stock when replenishment is received. In the third case, the rate of consumption being very fast (or the buffer having been fixed at a low level), the stock level reaches zero on the day replenishment is received.

There may be a situation when even after the stock has reached the zero level,

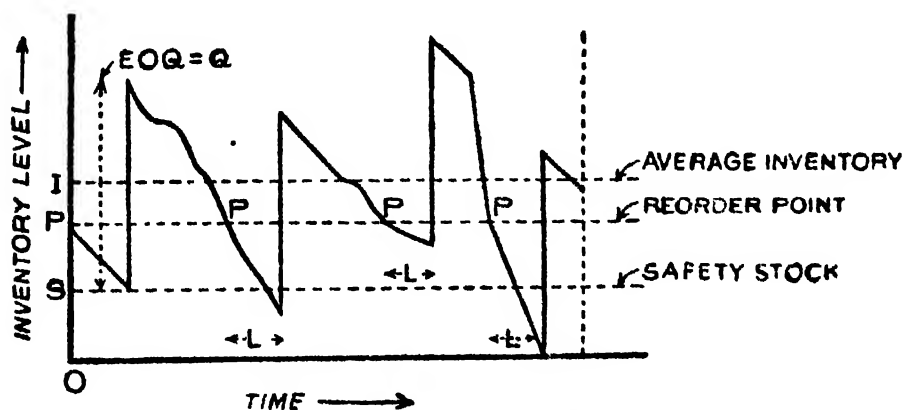


Fig. 2.4. Fixed order quantity model (variable consumption rate)

some time elapses before replenishment is received and so in the meantime, there is stock-out. In fact, the safety stock is not intended to completely eliminate stock-out. With higher levels of safety stock the percentage of stock-out is, no doubt, reduced but the cost of carrying higher stock may outweigh the cost of stock-out. When stock out costs are known the safety stock would be fixed at an optimum level where the cost of carrying the stock and the cost of stock-out would be at the minimum. The level is determined with the help of statistical method by estimating the probabilities of consumption during the re-order period or lead time. In most cases, however, it is very difficult to determine the cost of being out of stock. When stock out costs are not known the concept of service level is utilized for setting the safety stock level. In order to arrive at the level, a service level policy is decided upon, for instance a 95% service level would mean that the firm does not intend to completely eliminate stock-out but is satisfied if 95% of the demand can be met and the probability of being out of stock will be only 5% (100-95) of the time. The higher the level of service required in order to reduce stock out the higher will be the safety stock required to be maintained.

The methods of determining the safety stock under both the situations mentioned above have been discussed in Chapter 19.

When the lead time is not constant, the buffer stock is determined with the help of a simulation technique, known as Monte Carlo simulation (discussed in Chapter 19).

(b) **Replenishment system.** In the *replenishment system* of inventory management, there is no fixed ordering quantity but there is a fixed ordering time. Thus, there is no consideration of inventory costs. A replenishment level or maximum level is fixed beyond which the stock is at no time, expected to go. Stocks are reviewed at fixed periodical intervals and orders are placed for a varying quantity which is equal to the maximum level minus the stock in hand on the date of review. In deciding upon the reorder quantity, another factor to be considered is the time gap between the lead time and the time interval of review. If the lead time is greater than the time interval of review, the quantity to be ordered (i.e. maximum level minus stock in hand) is further reduced by the quantity already on order at the time of review.

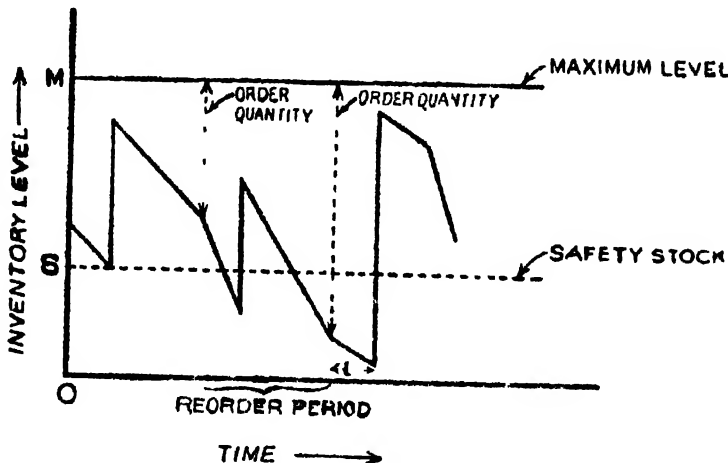


Fig. 2.5. Replenishment System

The maximum level is determined in accordance with the following formula :

Maximum level = Safety stock *plus* average consumption per unit of time
 (lead time *plus* time interval between two reviews)

$$M = S + C(L + R)$$

As in the case of the fixed order quantity system, the safety stock is fixed on the basis of the distribution of consumption around the average consumption during the lead time plus review time.

The model for this system is illustrated in Fig. 2.5. It will be seen that the order quantity is different for each review period.

(c) **Optional or modified replenishment system.** There is another system of inventory management, called the *optional replenishment system* by some authors, which is a modification of the replenishment method. In this system also, the ordering quantity is variable but a lower limit is placed on its size. The system thus combines the main features of the fixed order quantity and the fixed order time systems in as much as there is a maximum level, a re-order point, a variable order quantity (subject to a certain limit), and a system of periodic review. The ordering quantity in this system is :

Maximum level *minus* (stock in hand at the time of review *plus* the quantity already on order), provided, stock in hand *plus* the quantity on order is *more* than the *re-order point*.

Inquiry and Call for Quotations. After the decision to purchase a material has been made, the next step is to locate the convenient and economical sources of its supply. The purchase department is in constant touch with the market and maintains a list of supplier firms for each item of store required. Selection of a particular supplier is usually made after inviting tenders from possible sources of supply.

Inquiries or invitation for tender in a prescribed form, are addressed to prospective suppliers with the request to submit quotations or tenders, indicating whether they would be prepared to supply the materials required and if so, what would be the price and other ancillary charges, delivery time, terms of payment, mode of transport and any other conditions which they would like to stipulate. The design of a tender form has been given in Fig. 2.6.

In order to discourage non-reliable and undesirable firms from quoting, a deposit or earnest money is often required to be furnished by the tenderers along with their tenders. If costly samples or blue-prints are supplied along with the inquiry form, a charge may be made for them, or alternatively, the deposit may be made non-refundable.

There are four types of tenders commonly in use :

- (i) **Single tender :** The inquiry is addressed to only one selected firm. This is done where there is only one source of supply or when the material is a proprietary item.
- (ii) **Limited tender :** Such tenders are invited from a restricted number of firms who are generally known to stock the item required and who are on the approved list of suppliers maintained by the purchase department.

INVITATION TO TENDER						
To					No. Date.	
<p>Dear Sirs,</p> <p>The stores noted in Columns 1 and 2 below are required at the place stated in Col. 3. A copy of the terms and conditions of supply is enclosed.</p> <p>If you are interested in the supply, please fill in Cois 5, 6, and 7 and return one copy of this enquiry, duly signed in token of your having accepted the terms and conditions. Your reply should reach us not later than..... A security deposit of Rs..... should also accompany your reply. This amount will be returned in case we do not place an order with you.</p> <p>We also reserve the right to order for a quantity less or more than that stipulated in Col. 2. If, therefore, rates for small/large lots are different, these should be quoted separately.</p> <p style="text-align: right;">Yours faithfully,</p> <p style="text-align: right;">For and on behalf of.....</p>						
Particulars of Stores/Supplies/Services (1)	Quantity required (2)	Place of delivery (3)	Date of delivery required (4)	Quantity which can be supplied (5)	Rate	
					Per unit (6)	Price (7)
<p>We agree to supply the above on the specified term/terms mentioned below : (Additional charges, if any, such as Transportation, Sales Tax, Octroi duties etc. should be specified here)</p> <p>Station.</p> <p>Date.....</p> <p style="text-align: right;">Signature.....</p> <p style="text-align: right;">For and on behalf of</p> <p style="text-align: right;">(Suppliers)</p>						

Fig. 2.6. Form of Tender

- (iii) *Open tender* : For purchases involving considerable quantity and value, it is desirable to have competitive offers on wider basis. Tenders are called for by advertisement in newspapers, journals etc. and any firm is at liberty to quote, without any restriction. Tender forms are supplied on request to parties interested.
- (iv) *Global tender* : Tenders are invited from all parts of the world. These are for large contracts for supplies from foreign countries or when foreign collaboration in proposed projects is considered necessary.

Comparative Statement of Tenders. Tenders are received in sealed covers by the due date and are opened on the date and time stipulated for the purpose. In

some concerns, tenderers are invited to attend at the time of opening the tenders and the prices quoted are read out, the objective being to get competitive rates in future quotations. The details furnished in the tenders are summarised and tabulated in a Comparative Statement (Fig 27). This statement is scrutinised and the tender accepted by a person authorised to do so. Acceptance of a tender indicates that the terms offered by the particular firm are acceptable and it is proposed to place order on that firm.

COMPARATIVE STATEMENT OF TENDERS						
Material Required Specification Date			Last Purchase Date Rate			
Sl No	Name of parties	Rate quoted	Other charges and conditions	Remarks	Decision taken	Initial
Purchase Order reference no. and date						

Fig 27 Comparative Statement of Tenders

The person authorised to accept the tenders should be specified. Financial limits are laid down for various levels of management for the purpose of acceptance of tenders so that the value of a tender decides as to who would be the competent person to accept it. For major purchases other than routine purchases, representatives from the production department which is ultimately to use the material are also associated with the opening and acceptance of tenders. Various factors like price, quality, reliability of source, terms of delivery and terms of payment are considered and adjusted to a common denominator and the tender of the firm offering the best advantage is accepted. It is not necessary that the lowest tender would always be the most advantageous and in some cases, higher tenders may be accepted if they offer other compensating benefits like better terms of payment and delivery, superior quality of materials, continuity of supply and improved business relations. Lower tenders may also be discarded on the ground that the quoting firm is found to have resorted to price cutting to eliminate other competitors from the market or that it has failed to deliver goods on time in the past.

Purchase Price. The procedure for inquiry and tenders not only decides 'where to purchase' but also what price is to be paid for the purchase. One of the important functions of the purchasing department is to buy materials at the most economic price but the lowest price paid may not always be of advantage and purchases made at cut-throat prices from unreliable firms may lead to difficulties. Most likely, the deliveries may not be made or if at all they are made, the schedules

may not be adhered to. Sometimes, materials supplied may not be of the standard quality which, if not detected by the normal methods of inspection, may result in manufacturing losses later by way of rejection and defective work. The reduction in the purchase price obtained by the purchasing department thus turns out to be a false economy and the net effect is a loss to the concern.

The prices of most of the basic raw materials required for production are dependent on the market conditions and they move in accordance with the law of supply and demand. The purchase department keeps itself informed regarding the latest price trends with the help of market reports, trade papers and journals, reports by purchase agents and sales representatives of the suppliers, published catalogues, and price lists. In e.g. concerns that can afford to have a market research wing, valuable information is supplied by this section. In most cases, however, the system of competitive quotations by tender described above, is adopted for the purpose of getting the materials at the lowest possible price. Where materials of a proprietary nature are sold through sole selling agents, the purchase department has no choice in the matter except perhaps to explore the market for low priced substitutes. When the price of a material is administered, i.e. controlled and fixed by the Government, purchases can be made only at the administered prices. Wherever possible, purchase may be made direct from the manufacturers in order to eliminate middle men.

Purchase Order (Also known as Supply Order) Soon after the quotations are finalised and the supplier from whom materials are to be purchased is decided upon, a Purchase Order (Fig. 2.8) is placed on the firm asking them to deliver supplies. Tender is simply an offer but the purchase order forms a contractual agreement with the suppliers. Before sending out the order, it should be ensured that suitable funds have been provided in the purchase budget. The contents of the purchase order should be complete and definite and it should include full details so as to leave no room for ambiguity or misunderstanding. If the purchase order is not properly laid out, it may result not only in subsequent disputes and bad business relationship, but may also upset production schedules due to non-delivery or delayed delivery of materials.

Each purchase order is serially numbered and contains the date of its issue. This is necessary in order to facilitate cross linking so that supplier when received may be correctly identified and payment to the suppliers may be made promptly. The supplier quotes this number and date on the invoices and in all his correspondence. The quantity on order is stated in the purchase order in both figures and words. Difficulty arises where a material is measured in more than one physical unit. For example, the same material may be supplied sometimes by volume and sometimes by weight. In such cases, the factor for conversion from one unit to another should be specified in the purchase order.

The inspection clause in the purchase order specifies the standard of quality expected and the name and agency of inspection to ensure it. The price and terms of payment clauses specify besides the agreed price, details regarding taxes, duties, packing and transportation charges payable, cash and trade discounts, and the methods of payment, e.g. cash on delivery, or part or full payment of

proof of despatch. Sliding scale of prices related to the quantity supplied, if any, is specifically mentioned.

PURCHASE ORDER				
To		No.....Date.....		
Ref : Your tender No..... dated..... Please supply the following stores on the terms and conditions indicated below :				
Particulars of stores	Quantity ordered	Unit of quantity	Rate per unit	Total value
				Total Rs.
Date of delivery..... Place of delivery..... Mode of inspection..... Terms of payment..... To be despatched by..... at consignor's/carrier's/our risk Freight at the rate of..... payable by us/or, Delivery free at the site indicated above. Price variation clause, if any, and other conditions. Please acknowledge receipt of this order.				
				Signature
For office use Follow up : acknowledgement received on..... 1st Reminder..... 2nd Reminder..... 3rd Reminder..... Date delivered..... Date inspected..... Invoice No. and date..... Brought on charge (Voucher No. dated.....				

Fig. 2.8. Purchase or Supply Order

Miscellaneous clauses of the following nature may also be inserted in the purchase order, as considered necessary :—

- (i) The manner in which import licence and foreign exchange are to be obtained in respect of purchase from abroad.
- (ii) In case of running contracts for recurring supplies, *escalator terms or price variation clauses* providing for increase or decrease in the stated price consequent upon the occurrence of specified contingencies.
- (iii) Indemnity against dispute with a third party, e.g. in case of infringement of patents and other rights by the supplier.

- (iv) Method of settlement and arbitration in case of difference of opinion between the supplier and the purchaser
- (v) Extent of liquidated damages to be paid in case of failure to supply the full ordered quantity or a part thereof and in case of non-delivery on schedule, the right of risk purchase, i.e. option to purchase from other source and charge the excess cost of purchase to the supplier

Generally, four copies of a purchase order are prepared for distribution as under :

- (i) One copy to the supplier.
- (ii) One copy to the receiving department (Sometimes quantities are omitted from this copy. This compels the receiving department to have an independent count so that errors or malpractices are obviated.)
- (iii) One copy retained as office copy in the purchase department
- (iv) One copy to the accounts department

To ensure that the supplier has received his copy, his acknowledgement is looked for. This may be watched through the office copy of the purchase order.

Follow Up of Purchase Order. Adherence to the specified delivery dates of the various items ordered is important. Following up an order to ensure supplies are delivered on due dates is as important as placing the order. Inquiries are made at regular intervals to find out whether the suppliers will have any difficulty in abiding by the schedule so that if any delays are anticipated suitable remedial measures may be taken. In the extreme case where the suppliers express inability to supply, action can be taken well in advance for procurement from alternative sources. Thus follow up action safeguards against likely hold up in production due to non-receipt of materials.

Receipt of Materials and Inspection. Materials when received from the supplier are under the temporary custody of the receiving department. The materials are usually accompanied with one or both of the following documents :

- (i) *Advice of despatch*, which is sent by the supplier intimating despatch of materials from his premises
- (ii) *Delivery note or packing note* (popularly called *Challan*), which is received from the carriers who transport and deliver the materials

On receipt, the materials are checked with reference to the copy of the purchase order in possession of the receiving department. The quantity received is verified with the quantity on order, and the quality specified on the purchase order is checked by the inspection department. In small firms, there may not be a separate inspection department but inspectors may be attached to the receiving department or the Store.

Deficiency, if any, is noted and the matter is taken up with the suppliers for making up the shortage. The terms of the supply contract often stipulate that a claim for damages or loss etc. in transit should be preferred on the carriers. Excess supplies are either retained or returned to the suppliers as considered necessary by the appropriate management authority.

Goods received are inspected in accordance with the terms of purchase before they can be accepted and brought on charge. The extent of inspection is not uniform for all materials. For instance, where dependable standards have been laid down or when materials are of small value or where the quality of raw materials does not appreciably affect a final product, the inspection may not be very rigid. In such cases, inspection of only a portion of the quantity received, by taking random samples, would be sufficient. However, for materials of vital importance like raw materials for explosives factories or for pharmaceutical concerns and where the material cost is high, a cent per cent strict inspection will be necessary.

A form known as *Goods Received Note* (Fig. 2.9) is filled in to record the details of the materials received, and the certificate of inspection is endorsed on it. Alternatively, a separate Inspection Note is prepared and attached to the goods received note.

The goods received note is prepared in quadruplicate ; one copy is retained as office copy in the receiving department and another copy is sent to the purchase department for checking with the purchase order, for making memorandum entries showing completion of purchase, and for approving the invoice received from the supplier. This copy is then passed on to the accounts office for payment of the supplier's bill. The material along with the third and fourth copies of the goods received note is sent to the storekeeper who brings it on charge and places it in the appropriate bin. One copy is sent by the storekeeper to the cost department for pricing and posting in the stores ledger.

GOODS RECEIVED NOTE				
No. :		Purchase Order No.		
Date of receipt		Purchase Requisition No. :		
Name of supplier		Invoice No. :		
Carriers :				
Particulars of Goods	Quantity	Number of Packages	To be filled in Accounts Deptt.	
			Rate	Value
Received by		Brought on store charge by		
Quantity		Bin No.		
Accepted/Rejected		Stores ledger folio		
Inspector				

Fig. 2.9. Goods Received Note

The fact that the stores have been brought on charge is endorsed by noting bin number in the goods received note, under the signature of the store-keeper

or his assistant. The procedure in some concerns is to prepare a separate Receipt Voucher or Stores Received Note which gives details of the materials taken on stores charge. The quantity brought on charge is then entered in the 'receipt' column of the bin card and extended to the 'balance' column.

When stores are purchased for a specific job, note of the job is kept in the purchase requisition and purchase order and in such cases, one copy of the goods received note is sent to the department concerned instead of the Store.

Checking of Supplier's Invoice. After the despatch of the materials (sometimes simultaneously with it) the supplier sends an invoice which contains details of the material supplied and the value to be paid for it. The invoice thus constitutes a bill for which payment is due. On receipt, the purchase department checks the invoice with the following documents:

- (i) *Purchase Order* To verify whether the terms and conditions have been adhered to and the rates charged are correct taking into account the price variation, if any.
- (ii) *Goods Received Note* (already checked with the purchase order). To verify the quantity received with the quantity billed for.
- (iii) *Inspection Report* To check the quality of the stores received.
- (iv) *Goods Returned Note* For deduction to be made from the invoice for materials returned to the supplier.

If the invoice is found correct on verification, a suitable endorsement to that effect is made on it. Usually an invoice approval seal or stamp is put prominently on the invoice to prevent errors and to facilitate prompt payment by the accounts office. If any deductions are required to be made in order to correct excess or wrong amounts in the invoice, the invoice amount is suitably altered and a debit memo is sent to the supplier. *Debit memo* is a memorandum statement indicating the deduction made from the supplier's invoice and the reasons for it. Similarly, if any additions are necessary in the invoice, a *credit memo* stating the amount credited to the supplier is sent. Debit note is sometimes followed by the supplier's credit note acknowledging the overcharge.

The supplier's invoice duly approved, is passed on to the accounts office together with the copy of the goods received note, for accounting and payment. The value paid for the materials is entered by the accounts office in the column provided in the goods received note which is then passed on to the stores ledger clerk for entry in the stores ledger. Where separate receipt vouchers or stores received notes are prepared by the storekeeper for bringing materials on store charge, these documents are sent to the accounts office for pricing before they can be posted in the stores ledger. Where posting is already made in the stores ledger from goods received note, the invoice is verified to this effect before payment is made to the supplier.

Valuation of Materials Received. The general rule is that the invoice price, as billed by the supplier, should be accounted for in the ledger. But certain

problems and differing view points arise regarding the accounting of receipts. These are specified below :

(i) *Cash discount* : This is discount allowed by the supplier if payments of bills are made within the period specified. Opinions differ as regards the method of treatment of such discounts in costs. One view is that cash discount being in the nature of purely financial transaction, should not find place in costs. Where, however, payment of bills are regularly made in accordance with a prescribed routine, e.g. if the system in vogue in the company is to make such payments on fixed dates or within a pre-stipulated period, cash discounts become a usual and definite factor and as such should be taken into account in costs.

Exclusion of cash credits has the effect of inflating the cost of materials. On the other hand, if the material is brought on charge at the invoice value less the agreed percentage of discount, difficulty arises if some bills are not paid promptly and no discount is earned. In such cases, the difference between the amount credited and the discount received may be charged to overhead or to the Costing Profit and Loss Account or the Profit and Loss Account if the accounts are integrated, through a Store Adjustment Account.

(ii) *Trade and quantity discounts* : As the amounts of these discounts are already deducted from the invoice price, no difficulty arises in their accounting. In any case, the net amount after deduction of the trade discount is taken as the purchase price.

(iii) *Transport charges* : The terms of supply often provide for free delivery to factory premises, transport charges being included in the price quoted by the supplier. When, however, transport costs are paid separately, these should be added to the invoice price of the materials. Transport cost may be charged to overhead when it is not practicable to allocate such cost direct say for example, when several lots of different types of materials are received in one consignment. A third method is to predetermine a transport cost rate for each type of material and add it to the cost of the materials purchased. Any difference between the amount allocated and the actual cost is taken as overhead costs or adjusted to the Costing Profit and Loss Account or the Profit and Loss Account, as the case may be.

(iv) *Other amounts billed by the suppliers* : As stipulated in most contracts, the supplier adds to the invoice price several items such as sales tax, excise duty, custom duty, octroi, and store loading charges. These expenses should be added to the cost of purchases whenever they can be directly allocated to the particular materials.

(v) *Receiving, inspection, storage, material accounting, and purchase department costs* : As the expenditure incurred under these heads is too remote for the purpose of direct allocation to the cost of materials, it is best treated as overhead cost and recovered on the basis of the value of direct material issued or consumed in the jobs or processes or as general overhead to be apportioned to various cost centres on the basis of materials issued. If direct allocation is preferred, separate allocation rates are determined for each of the above types of expenses.

(vi) *Apportionment of joint purchase cost* : Sometimes, several grades of a material are purchased in one lot and the price paid is a common or average price for the whole lot. For purposes of production, each grade is required to be kept

separate for use against different production orders. In some cases, materials are purchased in one kind of unit of quantity but issued to production in another unit. For example, screws or nails of various sizes are purchased by weight but each size is stocked in separate bins and may be issued in numbers. In such cases, if only one price is maintained and entered in the stores ledger for all grades and sizes and all issues accordingly priced at a common rate, this would result in understatement of costs in some cases and overstatement in others. This is explained below :

100 units of each of three grades A, B and C of a material were purchased for Rs. 480

Average purchase price— $\frac{\text{Rs. 480}}{300}$ Rs. 1.60 per unit, for all grades

The three grades were utilized for three production orders X, Y and Z. Cost of material charged was

X	Y	Z
Rs. 160	Rs. 160	Rs. 160

Assuming that the market price per unit of the three grades if purchased separately, were Rs. 1.50 for A, Rs. 1.40 for B and Rs. 1.70 for C, the cost of production orders X, Y and Z should be Rs. 150, Rs. 140, and Rs. 170 respectively.

Thus the averaging of the price resulted in an overstatement by Rs. 10 for X and understatement by a similar amount for Z.

To eliminate the above difficulty, ~~each~~ grade or size of material is taken ~~on~~ charge on separate bin cards or folios of the stores ledger. The current market price of each grade is ascertained and the receipts priced accordingly. The difference, if any, between the total price paid for a lot consisting of mixed grades of a material and the aggregate of the market price computed separately for each grade, is distributed to the various grades *pro rata* to the market price for each. This does away with the necessity for any subsequent store adjustments.

Incidental costs of purchase incurred jointly for a number of consignments are also suitably apportioned to each item of material. This is illustrated below :

EXAMPLE 2.5

For posting in the stores ledger, what values you would adopt in respect of the different items in the following purchase invoice ?

	Rs.	Rs.
175 Kgs. of X at Rs. 2 per kg. (one case)		350
300 Kgs. of Y at Rs. 4 per kg. (two cases)	1,200	
Less trade discount 12½%	150	
		1,050
		1,400
Cash discount at 2½% for payment within 30 days		35
		1,365
Carriage		38
3 cases (non-returnable) at Rs. 4 each		12
		Rs. 1,415

(I. C. M. A., Inter—Adapted)

ANSWER :

Quantity (Kgs.)	X 175	Y 300
	Rs.	Rs.
Invoice value	350.00	1,050.00
Less cash discount $2\frac{1}{2}\%$	8.75	26.25
	341.25	1,023.75
Carriage (175 : 300)	14.00	24.00
Cases (1 : 2)	4.00	8.00
	Rs. 359.25	Rs. 1,055.75
Rate per Kg.	Rs. 2.05	Rs. 3.52

It may be noted that the above calculations have been made on the assumption that credit should be given for the cash discount. If the management decides otherwise, the cash discount will be excluded from the calculations.

(vii) *Extra quantity or spare parts received gratis* : It is the practice in some trades to supply additional lengths or weights or spare parts, free of cost. Such excess receipts should be properly accounted for in the bin cards and the stores ledger. As no value is attached to the receipts, this will have the effect of reducing the unit price of the consignment.

(viii) *Cost of containers* : The following situations may arise :—

- Packing boxes are received free with stores but sold at a value.
- Containers are non-returnable and their value is included in the invoice.
- Value of container is separately charged for but for which full value is credited when returned to the supplier.
- Returnable containers for which less value is credited on return.

Materials received with non-returnable containers are brought on charge at their full value inclusive of the cost of the containers. Thus for materials issued to production, proportionate cost of the container is automatically included in the issue rate and the entire cost is recovered in production as material cost. If the empty containers have a disposal value, the sale price is credited to overhead. Another method is to deduct the estimated sale price from the invoice price of the container so that its net value only is charged to materials cost. A third method is to ask the departments to return empty containers to the Store on materials return notes after the contents have been consumed. The return note is valued at an assigned rate and the value thereof is credited to the production order against which the cost of the container was originally charged.

In the case of returnable containers the value of which is refundable on return, the contents are brought on store charge at the invoice price less the value of the containers. The containers are kept on temporary charge or as a loan item in stock. Although the material and the container are kept together physically, the entries for the latter should be made in a separate bin card. When full credit is not given by the supplier for the return of containers, the difference between the invoice price and the credit value of return should be charged to the cost of the material.

In the books of the supplier, the cost of containers is treated as manufacturing cost or selling or distribution cost, as the case may be, as discussed in Chapter 5.

Provisional Pricing of Receipts. In most cases, there is a time lag between the dates of supply of materials and the receipt of the supplier's bill. Pricing of materials for taking them on stock charge presents a problem as the bill includes certain items like transport charges, taxes, duties, etc., the actual costs of which are not known till the bill is presented. Valuation of receipts cannot wait for the information because unless the goods received notes are priced and the receipts accounted for in the stores ledger, stores issues cannot be priced. In such cases, the goods received notes may be priced at provisional values. The material value is available from the purchase order, or the rate contract, if there be any. Escalation clauses, if any, in the purchase order should be kept in view and only the ruling price adopted. Valuation of the other charges is based on past actuals or on the conditions stipulated in the purchase contract.

When receipts are priced provisionally, a register should record all such transactions so that adjustments may be made when actuals are available. The adjustments are effected in three ways, illustrated below :

200 units of a material were priced provisionally at Rs. 200 ; actual price known later was Rs. 220 by which time, 50 units were issued for Rs. 50 leaving a balance of 150 units valued at Rs. 150.

- (i) *Adjustment to balance* : The difference of Rs. 20 is charged to the balance so that, after adjustment, the stock of 150 units is valued at Rs. 170
- (ii) *Adjustment of previous issues* : The value of 50 units is re-priced at Rs. 55 so that the stock of 150 units is now valued at Rs. 165.
- (iii) *Adjustment to overhead* . The difference of Rs. 20 is charged to overhead (store keeping expenses) ; the stock of 150 units stands unaffected at Rs. 150

Methods (i) and (ii) are mainly applicable when the value of the difference is small

Discrepancies in Material Receipts. While checking the materials received with the details in the purchase order, the Receiving Department may come across the following discrepancies :—

- (a) Quantity in excess,
- (b) Quantity short,
- (c) Quality not up to the standard.

The quantity supplied in excess may be retained and taken on charge provided need exists for the material and approval of the purchase department is obtained. If the excess quantity has already been billed for in the invoice, the amount is approved and paid. If not, either the supplier is asked to give a supplementary bill or the invoice is suitably amended and a credit note issued to the supplier by the purchase department.

Excess quantity, if not acceptable, is returned to the supplier on a Goods Returned Note (Fig. 2.10). One copy of the goods returned note is retained in the receiving office as office copy ; another copy is sent to the purchase department, and the third copy is forwarded to the supplier.

If the value of the excess supply returned is already charged in the invoice, suitable deduction is made therefrom by the purchase department and a debit note is issued to the supplier.

columns are posted to the respective ledger control accounts, such as Stock Control Account, Fixed Assets Account, etc. *Purchase Credit Book* records the details of debit notes issued to suppliers and is posted in the same manner as the Purchase Invoice Book. The totals of the entries are debited to the Trade Creditors Ledger Control Account and credited to the other ledger accounts.

Invoice No.	Date	Supplier or Creditor	Creditors Ledger Cr.		Stock Ledger Dr.		Cost Ledger Dr.		Fixed Asset Ledger Dr.		Sundry General Ledger Dr.	
			Ledger Folio	Amount	Ledger Folio	Amount	Ledger Folio	Amount	Ledger Folio	Amount	Ledger Folio	Amount

Fig 2.11. Purchase Invoice Book

Voucher No.		Date		Creditor		Voucher payable Cr.	Dr Material	Direct Labor Dr.	Factory Overhead Dr.	Selling and Distribution Overhead Dr	Administration Overhead Dr.	Capital Assets Dr.	Sundry Accounts Dr.

Fig. 2 12. Voucher Register

The purchase invoice book may be substituted by a *Voucher Register* (or *Accounts Payable Register*) which contains a record of all liabilities incurred, and the entries made from a specially prepared document, known as the Voucher. A materials receipt voucher is a statement of goods received made out from the creditors' invoices. Each voucher is serially numbered and entered in that order in the proper column of the voucher register (Fig 2.12). For example, direct material cost is posted in the direct material column and indirect material in the overhead column. At the end of the accounting period, the totals are posted to the appropriate ledger accounts in the same manner as in the case of the purchase invoice register. Vouchers are also prepared in respect of labour and overhead expenses from the pay roll records and expense invoices or statements, and are posted in the various columns of the voucher register.

As the postings made in totals in the control accounts as described above, are not sufficient for cost accounting and cost control, each individual receipt or issue transaction is recorded in detail in the bin cards and the stores ledger.

An example to illustrate some of the basic principles of materials purchase is given below.

EXAMPLE 2.6

C Limited is a manufacturing company which uses many different dyes in its production process.

The purchasing officer considers that it would be preferable to change the company's purchase policy. This would increase the average investment in the stock of dyes.

Show the savings, if any, in terms of return of the additional investment likely to arise from adopting the proposed new purchasing policy assuming that additional shortage costs and anticipated store losses will be Rs. 10,000 per year.

The dyes used by C Ltd. have been grouped according to price into four groups and the relevant data are

Group	Number of dyes in group	Basic price per kg Rs	Monthly Consumption of each dye			Order quantities	
			Minimum kgs	Average kgs	Maximum kgs	Present purchasing policy kgs	Proposed purchasing policy kgs
A	4	5.00	900	1,200	1,500	2,000	5,000
B	10	4.00	200	400	600	1,000	2,000
C	10	3.00	400	600	800	2,000	2,000
D	16	2.50	1,600	2,000	2,400	5,000	10,000

Each dye is purchased individually. The supplier's quoted discounts for quantities are nil, and 5%, 10% and 15% of basic price for 1,000 kgs, 2,000 kgs, 5,000 kgs, and 10,000 kgs, respectively.

The normal lead time from the supplier is two months although the maximum time is three months and the minimum time is one month. (I.C.M.A., Part II—Adapted)

ANSWER :

As there is no change in the order quantity for Group C, this group need not be included in the calculations. The increase in discount is

Group	Change in quantity Rs	Change in discount	Average annual consumption	Increase in discount
A	2 000 to 5,000	5% to 10%, i.e. 5%	1,200 12 4/ Rs 5 Rs 2 88 000	5% of Rs 2 88,000 Rs 14,400
B	1 000 to 2,000	0 to 5%, i.e. 5%	400 12 10 Rs 4 Rs 1 92 000	5% of Rs 1,92,000 Rs 9,600
D	5 000 to 10,000	10% to 15%, i.e. 5%	2 000 12 16 Rs 2 50 Rs 9 60,000	5% of Rs 9 60,000 Rs 48,000
				Rs 72,000

The increase in investment in stocks is the difference between the present average stock and the proposed stock. This may be worked out as follows:

Minimum Stock Re-order level *minus* average usage rate \times average lead time
Maximum usage rate \times maximum lead time *minus* average usage rate \times average lead time

Group

A	(1 500 \times 3) - (1,200 \times 2) = 2 100
B	(600 \times 3) - (400 \times 2) = 1,000
D	(2 400 \times 3) - (2,000 \times 2) = 3,200

Proposed Stock Minimum stock *plus* half re-order quantity

	Present	Proposed	Difference
A	[2 100 $\frac{1}{2}$ 2 000] (Rs 5 95) Rs 14 725	[2 100 $\frac{1}{2}$ 5,000] (Rs 5 9) Rs 20 700	Rs 5 975 4 Rs 23 900
B	[1 000 $\frac{1}{2}$ 1 000] Rs 4 Rs 6 000	[1,000 $\frac{1}{2}$ 2 000] (Rs 4 95) Rs 7 600	Rs 1 600 10 Rs 16 000
D	[3 200 $\frac{1}{2}$ 5 000] (Rs 2 50 9) Rs 12 525	[3,200 $\frac{1}{2}$ 10 000] (Rs 2 50 85) Rs 17 125	Rs 4 600 16 Rs 73 600
			Rs 1,13 500

Net total Rs 72 000 - Rs 10 000 = Rs 62,000

Return on the additional investment $\frac{\text{Rs 62 000}}{\text{Rs 1 13 500}} = 54.6\%$

STORAGE CONTROL

After the materials on order are received, checked and approved, the Storekeeper takes them on charge. He is responsible for placing the materials in their appropriate places inside the Store and for ensuring that they are maintained in good condition during storage till required for utilization in production. The control during this stage may be called Storage Control.

The Storekeeper (His functions and duties) The Storekeeper is responsible for the receipt, storage, and issue of materials. In many concerns, the volume and the cost of stores handled by the Stores department are fairly high. In order, therefore, to be able to exercise effective control, the Storekeeper should have a high place in the management hierarchy.

The duties of the Storekeeper may be summarised as follows :--

- (i) Carrying out a regular review of the physical existence of stores in hand. This has a two-fold objective, viz. placing requisitions for purchase on the purchase department when the stock reaches the reordering level, and locating slow-moving or non-moving items so that action may be taken for their disposal before they deteriorate or become obsolete and unfit even for alternative use.
- (ii) Receiving stores from the receiving department (in some factories there is no separate receiving department and its function is performed by the stores department), checking with the proper documents, and bringing them on charge.
- (iii) Entering all receipts in bin cards.
- (iv) Storing materials in their correct places in the stores department.
- (v) Making suitable arrangement for maintenance and preservation of the materials during storage :
Bins, shelves, racks and other containers should be conveniently placed. The number of receptacles and their placing should be such as to utilize the storage space to the best advantage.
Action to prevent deterioration, evaporation, absorption of moisture, etc. should be taken.
There should be proper arrangements for stocking. Suitable aisles and gangways should be provided for speedy handling. Scales, weighing machines etc. should be conveniently placed. The stores should be suitably marked for the purpose of easy identification and accessibility.
- (vi) Issuing correct materials against demand under proper authority and correctly recording the issues. Entering issues in bin cards.
- (vii) Taking back surplus materials returned from departments or shops.

Location and Organisation of the Stores Department. The practice in most concerns, both small and big, is to have a central store that is responsible for the handling and upkeep of all types of stores. Separate stores to cater to the needs of each production department are uncommon because of the heavy expenditure involved. Centralised store offers the following *advantages* :—

- (i) It is economical.
- (ii) Specialised knowledge and experience of stores staff is available.
- (iii) It ensures better control and supervision.
- (iv) It needs less storage space.
- (v) Better layout facilitates, prompt issue of materials and smooth stock verification.
- (vi) As all stores are located in one place, it is convenient to control the physical stock balances. The risks of obsolescence of stores are, therefore, minimised.

On the other hand, the *disadvantages* of a centralised store are :

- (i) Internal transport cost increases, particularly when the departments requiring the materials are situated at a considerable distance from

the store. This also increases the risk of damages or loss of stores during transit to the departments

- (ii) There is likelihood of delay in meeting demands. The delay is aggravated if there is a breakdown of transport. If issues are not promptly made, production may be hampered.
- (iii) Concentration of all types of materials at one central place enhances the risk of loss due to fire.

To obviate the above difficulties, the ideal solution is to have a central store and in addition, sub-stores or departmental stores in each main production department under the overall control of the central store. For the job stores, imprest system may be used under which replenishment of each item of stores is made at the end of a period so as to bring its stock to a pre-determined level.

The important considerations that should be kept in view while determining the location of the store in the factory are as follows:

- (i) The store should be near the road, railway siding or rail head, or wharf so that incoming goods can be conveniently handled.
- (ii) The receiving department should also be in proximity to the store godown.
- (iii) In order to reduce internal transport cost, the store should be centrally situated so as to be easily accessible to the producing departments which consume the materials.
- (iv) Heavy and bulky items should be stocked very near the departments which use them most.
- (v) Similar types of material should be stored in one place.

Classification and Codification of Materials. For the purpose of identification and for convenience in storage and issue, each item of stores is given a distinct name. Similar items are classified under sub-groups and a number of such sub-groups are classified under main or major groups. For example, items of brass may be classified under sub-head 'non ferrous metals', and under the main head 'metals'.

Classification of stores should be accompanied with a suitable system of codification. Codification is the procedure for assigning symbols, either numeric or alphabetic, for each item in accordance with a proper arrangement. Thus, besides its name, an item of stores is also known by the symbol allotted to it.

Codification has the following *advantages*:-

- (i) Ease in identification of stores. Suitable codes or symbols indicate the location so that issues may be made with promptitude and ease. This is particularly useful where the same material is known by more than one name.
- (ii) Writing full names and particulars of materials on documents is dispensed with so that clerical work is reduced. This also economises space in forms.
- (iii) In mechanised accounting, codification is essential.
- (iv) Quoting symbols along with nomenclature ensures clarity.
- (v) To some extent, symbols and codes ensure secrecy because the codes are not available to all and sundry in the concern.

The essentials of a good system of codification are clarity, conciseness, definiteness, flexibility, ease of application, and minimum expenditure in operation

There are three methods of codification :

- (a) *Numeric* : Each item is allotted a numeral. The numbering may be straight or in groups or blocks. Sub-groups may be indicated by decimals. For example if metals are denoted by 15, non-ferrous metals by 2, brass strips by 41, and $\frac{3}{8}$ " thickness by 11, Brass Strips $\frac{3}{8}$ " will be denoted by 1524111. This method of codification allows a wide range and is, therefore, most suited where the number of items is very large.
- (b) *Alphabetic* : Each item is denoted by a combination of the alphabets. If the alphabet selected indicates the first sound when the name of the store is pronounced, the system is known as the *mnemonic system*. For example Brass Strips may be denoted by the code MNB (i.e. M for metal, N for non ferrous and B for brass). Mnemonic system helps in memorising the codes.
- (c) *A combination of numeric and alphabetic systems* : In the above example, MNB 38 may indicate Brass Strips of $\frac{3}{8}$ " thickness.

The utility of the code is further enhanced if *Location codes* are also suitably built into the code system. A location code refers to the place or bin where the particular material is stored so that from the code one can easily find out the physical location of the material. For example, a location code 02011242 indicate that the particular material is stocked in godown number 02, aisle number 01, rack number 12 and bin number 42.

An illustration showing a method of codification is given in the example below :

EXAMPLE 27

T Limited produces timber which it sells in 10 feet length. The size of the timber produced varies from $\frac{1}{2}$ " to 12" width and from $\frac{1}{4}$ " to 2" in thickness. A coding system is used, parts of which are as follows :

Softwood	5" \times 1 $\frac{1}{2}$ "	Code 11014
Hardwood	7 $\frac{1}{2}$ " \times 1 $\frac{1}{2}$ "	Code 21510
What code should be used for the following materials?		
	Hardwood	1 $\frac{1}{2}$ " \times $\frac{1}{4}$ "
	Softwood	4 $\frac{1}{2}$ " \times $\frac{1}{2}$ "

What do the following codes represent ?

11915

21512

The company decides to stock as a new line, 6 feet dowelling in diameters from $\frac{1}{4}$ " to $\frac{3}{4}$ ". Suggest a suitable coding within the system and give as example the code for $\frac{3}{4}$ " diameter dowelling. (I.C.M. 1, Inter)

ANSWER :

The first digit indicates the kind of wood, the next two digits the width and the last two digits, the thickness. Accordingly,

Code for .

Hardwood 1 $\frac{1}{2}$ " \times $\frac{1}{4}$ " is 20305

Softwood 4 $\frac{1}{2}$ " \times $\frac{1}{2}$ " is 10906

Code 11915 represents Softwood 9 $\frac{1}{2}$ " \times 1 $\frac{1}{2}$ "

Code 21512 represents Hardwood 7 $\frac{1}{2}$ " \times 1 $\frac{1}{2}$ "

For the dowellings we need only two digits to indicate the dimension, i.e. the diameter. For this purpose either the 2nd and 3rd or the 4th and 5th digits in the existing code system may be used. The pair of digits not needed is to be indicated by 00. Thus Softwood dowellings of $\frac{1}{4}$ " diameter may be indicated by 10002 or 10200 and Hardwood dowellings of $\frac{1}{4}$ " diameter may be indicated by 20006 or 20600.

Perpetual Inventory (or Automatic Inventory) System. The control of materials while in storage is effected through what is known as the Perpetual Inventory. Inventory means here, a list of goods in hand and the term, 'perpetual inventory' derives its name from its function of indicating at all times, the balance of each item of stores in hand. Thus, the two main functions of the perpetual inventory system are :

- (i) Recording store receipts and issues so as to determine at any time the stock in hand, in quantity or value or both, without the need for physical count of stock.
- (ii) Continuous verification of the physical stock with reference to the balance recorded in the stores records, at any frequency, as convenient for the management.

Perpetual inventory system comprises .

- (i) *Bin Cards* (Quantitative perpetual inventory).
- (ii) *Stores Ledger* (Quantitative cum Valued perpetual inventory)
- (iii) *Continuous Stock-taking* (Physical perpetual inventory).

Bin Card (Known also as Bin Tag or Stock Card). A Bin Card is a quantitative record of receipts, issues, and closing balances of items of stores. Separate bin cards are maintained for each item and are placed in shelves or bins or are suitably hung up as convenient, alongside the materials in godowns. A specimen form of a bin card is given in Fig. 2.13.

On receipt of a consignment of materials, suitable entry of the quantity is made in the receipt column of the bin card from Goods Received Note. Similarly, issues of materials to the shops, departments or outside parties are entered in the issue column. All these entries are supported by receipt or issue documents, as the case may be. The main feature of a bin card is that after posting a transaction, whether relating to receipt or issue, the balance quantity is calculated and recorded. Stores returned from the departments are recorded either as receipts or as minus entries in the issues column.

The various levels indicated in a bin card enable the storekeeper to keep a watch on the balance and to place requisitions for replenishment as and when necessary. Sometimes, columns are also provided for noting the quantity on order and the quantity reserved for particular production orders. For determining whether the balance has reached the ordering point, the quantity reserved is taken as issued and is deducted from the balance in hand. Another practice is to physically segregate materials reserved or stock-piled and to maintain records thereof in a separate set of bin cards.

BIN CARD							
Description :			Maximum Level :		Stock verification		
Stores Code No. :			Minimum Level :		Date	Initials	
Location :			Re-ordering Level :				
Unit of measurement :							
Date	Document Number	Source of receipt or Issued to	Receipt	Issue	Balance	Verification with Stores Ledger	
						Date	Initial

Fig. 2.13. Bin Card

The *Two-bin system* adopted by some firms facilitates physical verification besides easy handling and better physical control of the materials. In this system, two sets of bins are maintained for each item of material. One set of bins is kept completely full and from which no issues are usually made. The other set constitutes the regular bin from which issues are made. As the stock balances of the complete bins are already known, it would be sufficient to physically count or measure the stock in the other set of bins. In another system, the first bin contains stock to cover usage occurring between receipt of an order and the placing of the next order. The other bin contains normal quantity to be used from the date of placing an order to the date of delivery including safety stock. New supply is ordered as soon as the first bin is empty. This two-bin system facilitates physical review of stock by the storekeeper for the purpose of placing purchase requisitions.

Stores Ledger. Like bin cards, Stores Ledger is maintained to record all receipt and issue transactions in respect of materials with the difference that along with the quantities, the values (sometimes also the rate per unit quantity) are entered in the receipt, issue, and balance columns. Additional information as noted in bin cards regarding quantity on order and quantity reserved, together with their values may also be recorded in the stores ledger but the common practice is to record such transactions only in one of the two sets of documents.

A form of stores ledger is given in Fig. 2.14. Like the bin cards, separate ledger sheets or folios are maintained in the stores ledger for each item of material. The ledger sheets are generally in loose leaf form in binders, separate binders being used for each class of materials. Another method is to arrange the binders according to location of stores, separately for each godown. The sheets are numbered serially and initialled by a responsible official so as to obviate the risk of removal or loss. In some concerns, the stores ledger is maintained in bound

[illegible]

Fig. 214. Stures L der r

Note The quantity reserved may be in a purpose of maintaining or stock for future needs. The quantity in stock reduced by the quantity reserved would be the free balance of the item.

volumes so as to rule out the possibility of loss of folios. The loose leaf system has, however, the advantage of flexibility (new sheets may be inserted and old ones weeded out at will), and facility in handling and posting.

Maintenance of bin cards along with the stores ledger is at times considered to be a duplication of work. It is, however, advantageous to retain both the sets of records, for the following reasons :-

- (i) Bin cards are not accounting records. It is essential that these be located with the stores in the various godowns.
- (ii) Stores ledger is maintained centrally in the Cost Office from where consolidated information may be made available.
- (iii) Stores ledger constitutes a second check on the quantity recorded in bin cards.
- (iv) Frequent overall review of store balances may be conveniently made with the help of the stores ledger.

Reconciliation of Bin Cards and Stores Ledger. After posting in the bin cards, the receipt and issue documents are valued and then passed on to the stores ledger clerk for entry in the ledger. Thus, normally there should be no difference between the balances shown in the two sets of records. In practice, however, differences arise mainly due to the following reasons:

- (i) Arithmetical error in working out the balances.
- (ii) Non posting of a document either in a bin card or in the stores ledger. Sometimes difference arises due to non-receipt of a document by the stores ledger clerk although it may be posted in the bin card. This may be avoided if a list indicating the serial numbers of all the documents made out in a period is prepared and a check is exercised to ensure that all the documents listed are received and posted.
- (iii) Posting in the wrong bin card or in the wrong sheet of the stores ledger.
- (iv) Posting of receipt documents in the issue column or vice versa.
- (v) Materials issued or received on loan or for approval are sometimes entered temporarily in the bin cards only. Such transactions are not priced and they are not posted in the stores ledger.

Any difference between the bin cards and stores ledger defeats the purpose for which the two separate sets are maintained and renders physical stock-taking ineffective as the correct book balance for the purpose of comparison with the physical balance is not available. The difference should, therefore, be reconciled and corrected at regular intervals. For this purpose, it is essential to keep all the postings up-dated. If the closing balances on a particular day do not agree, all the previous transactions should be checked in order to locate the difference. Another method that facilitates automatic reconciliation is to note the stock balances on all the receipt and issue documents after they have been posted in the bin cards. At the time of posting these documents in the stores ledger, the balances can be tallied with the stores ledger balances. This method, however, involves extra work and its significance is eventually lost if postings are not made strictly in the chronological order.

Continuous Physical Stock Verification. The perpetual inventory system is not complete without a systematic procedure for physical verification of stores. The bin cards and the stores ledger record the balances but their correctness can be verified by means of physical verification only. The books indicate what the balances 'should be' or 'should have been', whereas a physical check would reveal what the balances 'actually are'. The process of physical check under the perpetual inventory system is outlined below.

(a) The stock verification staff plan the programme of stock-taking in a systematic manner with proper distribution of work among themselves about counting, weighing, measuring, and listing the stock.

(b) Different sections of the store are taken up in rotation. The programme should be so planned that in the course of a year, the entire range of items is covered. Some items may need verification at intervals of less than a year according to their importance or the degree of control desired. On the other hand, bulky items of smaller values may be verified only once in two or even three years. Usually the programme is so arranged that bulky items are verified during periods when their stock is comparatively low, special care being taken not to break the full stacks, bins or packings so that the pre-stated capacity of the container may be taken to represent the measure of stock.

(c) Notice of the particular stock to be verified each day is given to the storekeeping staff only on the date of actual verification.

(d) Consignments of stores received in the godown but not brought on charge pending inspection or documentation, or due to other causes, should not be mixed up with the stock on bin charge at the time of stock verification.

(e) The physical stock of an item in the godown is counted, weighed, or measured, as the case may be, and the results of stock verification suitably recorded. Three methods of recording the results of stock verification are described below.

(i) *Inventory Tags.* A proforma for inventory tag is given in Fig. 2.15. The tag consists of two portions. The upper portion is attached to the particular stores bin at the location to indicate that the item has been verified. Any bin to which no inventory tag is attached would indicate that the item is still to be verified. The lower portions of the tags are torn off and kept together. These serve the purpose of records of stock verification which when valued represent the balance of stores in hand.

Inventory tags are most suitable for periodic stock verification, discussed later in this section. The verification, particularly of the slow-moving items, can be done in advance of the last date fixed for stock verification. The columns provided at the bottom of the tag record information regarding the receipts and issues between the actual date and the last stipulated date of verification. This is useful if verification is done without shutting down the factory. For the purpose of final accounts, the closing balance in hand is represented by the quantity on physical count plus the subsequent receipts and minus the subsequent issues. In case of physical verification done after the stipulated date, the earlier receipts and issues have respectively to be deducted or added.

(ii) *Record in bin cards:* Instead of maintaining separate inventory tags, the results of stock verification may be entered in the bin cards. The balance

found on physical verification is entered, preferably in red ink, in the line next below the last entry in the balance columns of the card. The physical count etc made by the verifier is taken to be authentic and is entered in the bin card even if it differs from the bin card balance. The date of stock verification is also entered in the column provided for the purpose so that a visual check of the records indicates whether any item has been left unverified.

INVENTORY TAG		
Store Code (Bin card Ledger folio No.)	No	Unit Code No.
Nomenclature	Stock verifier	
Quantity	Date	
Store Code	No	
Nomenclature	Unit	
Quantity	Stock verifier	
Godown No.	Date	
Date	Issue after verification	Receipt after verification

Fig. 2.15 Inventory Tag

(iii) *Stock verification sheets* (Inventory records) In the methods described above, it is necessary to record the result of stock verification in a separate record or sheet (Fig. 2.16). The sheets are maintained datewise so that when a ranged together they give a chronological list of the items verified. The quantity actually found on stock verification is noted in the proper column by the stock verifier who also enters in the verification sheet the balance on date as shown in the bin card. The sheet is then sent to the stores ledger clerk who enters the balance as recorded in the stores ledger. Thus, for each item of store in the stock verification sheet, there are three sets of entries for the quantity.

Periodic Stock Verification. Besides the method of continuous stock verification described in the foregoing section, there is another system known as the periodic stock verification. Under this system, the entire stock is verified all at a time at periodic intervals, usually once a year. It is advantageous to have the verification at the close of the annual accounting period so as to facilitate valuation of stores for exhibition in the final accounts. An alternative practice is to arrange the verification in such a manner that the stock-taking coincides with a period of slack business activity. Periodic stock-taking usually necessitates the shut down of the factory and it should, therefore, be completed as quickly as possible. Stock may also be verified at intervals of less than a year if so desired but such a course is expensive.

The need for stoppage of activities even for small periods for the purpose of stock verification makes the method costly. Another defect is that, because no regular or special staff is employed for stock-taking, inexperienced men from all divisions of the concern have to be drafted at short notice for assistance. As these men have neither the aptitude nor the required technical ability for the work, the result of stock-taking is not accurate and it cannot be relied upon. Further, periodic stock verification is too weak a system to obviate the risk of pilferage, loss, or theft because of the long and at the same time, fixed and known intervals between two consecutive stock-takings.

Periodic verification is, however, necessary for stores that do not find place in the perpetual inventory records, such as work-in-progress, consumable stores and components drawn from stores but not fully utilized, capital assets, loose tools and spares lying in the shops, and measuring devices and tools in the custody of inspection staff. Some managements prefer to have annual stock-taking for selected items in addition to continuous stock verification as a sort of double check.

Reasons for Surpluses and Deficiencies in Stock-Taking and Accounting thereof. Surplus and deficiencies revealed in course of stock-taking may arise due to the following :—

- (i) Normal deficiency, e.g. evaporation, dryage, shrinkage, etc. of materials in the normal course, and normal surplus, e.g. absorption of moisture etc.
- (ii) Stores misplaced.
- (iii) Errors in stock-taking.
- (iv) Accounting errors such as non-recording of receipt or issue, or wrong posting of receipt, issue, or closing balance entries.
- (v) Errors in issues, e.g. short or over issue, wrong measures, difference in scales, issues in small quantities, etc.
- (vi) Breakage and wastage due to careless handling.
- (vii) Theft, pilferage and heavy losses.

The method of accounting adopted for adjustment depends on the nature of the surplus or deficiency and the amount involved. Normal surplus and deficiency, referred to at item (i) above, arise due to the inherent properties of the materials

concerned and as such, their quantum is anticipated. A normal percentage for surplus or deficiency is predetermined for each type of material and the unit price of the material is reduced or inflated to cover the cost of the normal percentage of surplus or deficiency. Any difference between the anticipated and actual discrepancy is noted on a *Stores adjustment note* and the value is adjusted to overhead or to the Costing Profit and Loss Account or the Profit and Loss Account, as the case may be. This is illustrated below :

Purchase : 1,000 units of a material at Rs. 1.92 per unit = Rs. 1,920
 Anticipated loss on shrinkage : 4%, i.e. 40 units

Inflated issue price = $\frac{\text{Rs. } 1,920}{1,000 - 40} = \text{Rs. } 2.00 \text{ per unit}$

If actual loss is 30 units only, 970 units will be issued at Rs. 2 per unit, i.e. at a total of Rs. 1,940, resulting in an excess credit of Rs. 20 in the Stores Account. This will be adjusted as follows :

	Rs.	Rs.
Dr. Stores Control Account	20	
Cr. Stores Adjustment Account		20

The Stores Adjustment Account is closed either to Factory Overhead Control Account or to the Costing Profit and Loss Account or the Profit and Loss Account.

Surpluses and deficiencies, other than normal, are adjusted to the Overhead Control Account. The amount of such discrepancies will not ordinarily be heavy. Separate Standing Order Numbers are allotted for surplus and deficiency caused by each factor. In the journal, the entries will be :

Dr. Stores Control Account
 Cr. Factory Overhead Control Account
 (Surplus in stock-taking)

Dr. Factory Overhead Control Account
 Cr. Stores Control Account
 (Deficiency in stock-taking)

The above entries may also pass through the subsidiary account, viz. Stores Adjustment Account or Stock Shortage Account.

The values of deficiency due to theft, pilferage, and loss, and surplus and deficiency, the amount of which is heavy, are treated as abnormal items not chargeable to costs. The journal entry is,

Dr. Profit and Loss Account
 Cr. Stores Control Account
 (Loss due to pilferage written off)

Wrong issues from Stores or returns from shops are adjusted to Work-in-Progress Account.

The adjustments made in the stores ledger consequent upon differences found in stock verification are illustrated in Example 2.8.

EXAMPLE 2.8.

The following differences are noticed in the physical verification of stores. State how you would adjust in the Stores ledgers and prepare the necessary journal entries for the cost ledger.

Material	Physical balance (units)	Ledger balance (units)	Issue rate per unit Rs.	Reasons
A	500	550	1.00	Shortage is due to theft. A receipt of 100 units was not recorded in the stores ledger. The balance of 50 units of the excess is due to errors in issuing from Store.
B	550	400	0.50	
C	540	550	2.00	Discrepancy is shown erroneously due to careless stock-taking.
D	500	510	—	Deficiency is considered normal and within limits.

(I. C. W. A., Inter)

ANSWER :**Material A :**

Shortage due to theft is written off to Costing Profit and Loss Account but in view of the small amount involved in the case under consideration, this may as well be charged to overhead, 50 units @ Re. 1 per unit amounting to Rs. 50 should be adjusted by the preparation of an adjustment voucher. The journal entry should be :

	Rs.	Rs.
Dr. Stores Adjustment Account	50	
Cr. Stores Control Account		50
(Adjustment of shortage of goods due to theft)		

The Stores Adjustment Account may be closed to the Costing Profit and Loss Account or the Overhead Control Account.

The adjustment voucher is posted in the store ledger in the issues column so that the book balance agrees with the physical balance.

Material B :

The errors of 100 units in receipt and 50 units in issue should be located and rectified. The receipt is corrected simply by recording it in the stores ledger. The erroneous issue is adjusted by a minus entry made in the issue column. The journal entry will be as follows :—

	Rs.	Rs.
Dr. Stores Control Account	25	
Cr. Work-in-Progress Account		25

If the error cannot be located, it is adjusted to overhead.

Material C :

No action is to be taken in the accounts except to correct the stock verification figures.

Material D :

The deficiency of 10 units should be adjusted by making an adjustment issue voucher for quantity only. No journal entry is required. Only the unit price of the material is inflated to cover the deficiency. An alternative method may be to charge the cost to overhead.

Advantages of the Perpetual Inventory System. The advantages of the perpetual inventory system are summarised below :

(a) Physical stocks can be counted and book balances adjusted whenever desired without waiting for the entire stock-taking to be done at the end of the

year. Under this system, therefore, closing the factory for the purpose of annual stock-taking may not be necessary.

(b) Prompt availability of stock figures enables quick compilation of Profit and Loss Account for interim periods.

(c) Discrepancies are easily located and thus, corrective action can be promptly taken to avoid their recurrence. Periodical checking of stores also fixes responsibilities and has a moral check on the staff. This lessens the risk of loss, pilferage, etc.

(d) Fixation of the various levels and check of actual balances in hand with those levels assist the storekeeper in maintaining stocks within limits and in initiating purchase requisitions for correct quantity at the proper time.

(e) Correct stock figures are readily available for insurance purposes and for seeking loans against stock from banks and other financing institutions.

(f) A systematic review of the perpetual inventory reveals the existence of surplus, dormant, obsolete, and slow-moving materials so that remedial measures may be taken on time. This has been discussed in the next section.

The perpetual inventory system has some *limitations* as well. Unless the bin cards and the stores ledger are kept up-to-date, effective control cannot be exercised and the work of continuous stock-taking is hampered. The necessity for an agreement between the bin cards and stores ledger balances further aggravates the problem.

Identification and Prevention of Slow-and Non-moving or Obsolete Materials.

Many business concerns carry large inventory that are slow-moving or non-moving. Slow-moving items are those whose rate of consumption or sale is low compared to their stockholding so that heavy stocks have to be maintained for a long time till the item is used up. Dormant stores constitute a type of slow-moving items the consumption or sale of which is occasional; there are long intervals between two consecutive issues. Non-moving items are those which have not been issued for a long period of time. When such items are found to be of no use to the business in any manner whatsoever in the near future, these are termed obsolete stores.

It will be apparent from the definitions of the various terms given in the preceding paragraph that no universally suitable norms can be fixed for these items. Each concern has, therefore, to lay down specific guidelines in this regard such as what should be the optimum rate of issue below which an item should be considered to be slow-moving, what should be the issue interval for an item to be called dormant or what length of time should elapse before an item is categorised as non-moving. For an item to be declared obsolete, two conditions should be laid down, viz. that the item would not have been consumed or sold, as the case may be, for a minimum specified period of time and that it would not be required by any department of the company in the near future. In certain cases, however, the first condition may not be satisfied and even current items may suddenly become obsolete. Since the disposal of obsolete items results mostly in loss, proper authorisation at the appropriate level should be obtained for classifying an item of material as obsolete.

A continuous review of the stores ledger folios will reveal the presence of slow-moving and non-moving items of materials. These can also be identified at the time of stock taking, whether continuous or periodic. The rate of stock turnover, i.e. the ratio of cost of materials used to average stock of materials is a good indicator of slow-and non-moving items.

An efficient system of purchase and storage control should be able to obviate slow-and non-moving materials but in practice, this is hardly so. The reasons for materials becoming slow-moving, non-moving or obsolete are :—

- (i) Failure of the purchase department.
- (ii) Ineffective documentation and no review of the stores ledger.
- (iii) Change in design and other technological changes in products and processes of manufacture, use of substitute materials etc.
- (iv) Failure to locate and report on slow-moving items and to recommend alternative use on time. Some of these items become obsolete later in course of time.

Whenever excess inventory arises due to slow or non-movement or due to obsolescence, immediate action should be taken to reduce it through various means such as exploring probable alternative use, return to the supplier or disposal by sale.

The ABC Method of Stores Control. Based on the concept of *Selective Inventory Management*, the ABC method is an analytical method of control which aims at concentrating efforts in those sectors where attention is needed most. The method follows from the general principle of Pareto (Wilfredo Pareto, Italy, 1896) that "in any series of elements to be controlled, a selected small fraction in terms of numbers of elements would always account for a large fraction in terms of effect." In large organisations, the materials may be classified into a number of categories according to their importance, namely their value and frequency of replenishment during a period. One category, which we may call the group 'A' items, may consist of only a small percentage of the total items handled but may have a combined value that constitutes a major or large portion of the total stock-holding of the business. The second category, consisting of group 'B' items may be relatively less important. In the third group, consisting of 'C' items, we may place the rest which is of least importance, i.e. this group may consist of a very large number of items, the value of which is not high.

The classification of the items into the categories A, B and C is made on the basis of such factors as their value of consumption, investment value, i.e. the value of stock, or sales or profit potential—the last named factor being more relevant in a trading concern. For example, high value items of goods or items that yield high percentages of profit and thus have more earning power per rupee of cost may be grouped under the A category. Classification of the items under A, B and C categories may also be made according to shortage (or stock-out) costs, length of lead times, seasonal availability, licence laws etc., besides their values.

Since the classification of inventory into various categories depends upon a large number of factors such as the nature and varieties of the items, nature of the business and the products manufactured, specific requirements of the concern etc.,

the ABC classification may be made in several ways. Under one such procedure, all the items of inventory are first, listed out and each item is valued. The value is obtained by multiplying the average estimated consumption of an item during a period by its unit cost. The items in the list are then rearranged in the descending order of their values irrespective of their quantities. Thus, 200 kgs. of an item valued at Rs. 20,000 will rank earlier to 20,000 kgs. of another item the value of which is Rs. 18,000. A running total of all the values is then taken. It will usually be found that a large percentage of the total value is covered by the first few items in the list. A decision is now taken as to the percentages of the total value (or the total number of items) which should be covered by the A and B categories. For example, the management may decide that 70% consumption value items, i.e. such of the items, starting in order from the first to the one which makes up 70% of the total consumption value, may be considered to be A items; the next set of items whose aggregate value covers, say 20% of the total, as B items and the remaining (i.e. with 10% of the total value) as C items.

An example of ABC analysis is given below :

Class	Number of items	Percentage of the total number of items	Total annual usage value Rs.	Percentage of the total value ,	Average value per item Rs.
A	300	6	5,60,000	70	1,866
B	1,500	30	1,60,000	20	107
C	3,200	64	80,000	10	25
	<u>5,000</u>	<u>100</u>	<u>8,00,000</u>	<u>100</u>	

The above table may be depicted graphically as in Fig. 2.17.

In the illustration, 'A' items represent 70% of the total investment but as little as only 6% of the number of items. A closer watch is kept on these items and stricter control must obviously be applied on these items right from the initial stages of estimating requirements, fixing the minimum stocks, lead time, etc. The lead time and the production time may be minimised to avoid locking up of capital and at the same time, higher protection, say up to 98% may be given against the risk of stock-out. Thus, with the minimum of effort, control is exercised over items of comparatively high importance.

Group 'B' ranks next in importance and not so strict control procedures need be followed in regard to the items in this group. Group 'C' items comprising 64% in quantity but only 10% in value, need only a simple and inexpensive system of control in which some of the routine work may be relaxed. For example, only quantitative records (bin cards) may be maintained for a group of these items and issues may be priced at standards. In certain circumstances, if it is possible to exercise proper physical control over their usage, the normal accounting procedure may even be dispensed with. Orders for items in this group may be placed in larger numbers or in bulk, say, for six months' or a year's consumption, in order to economise on ordering and handling costs.

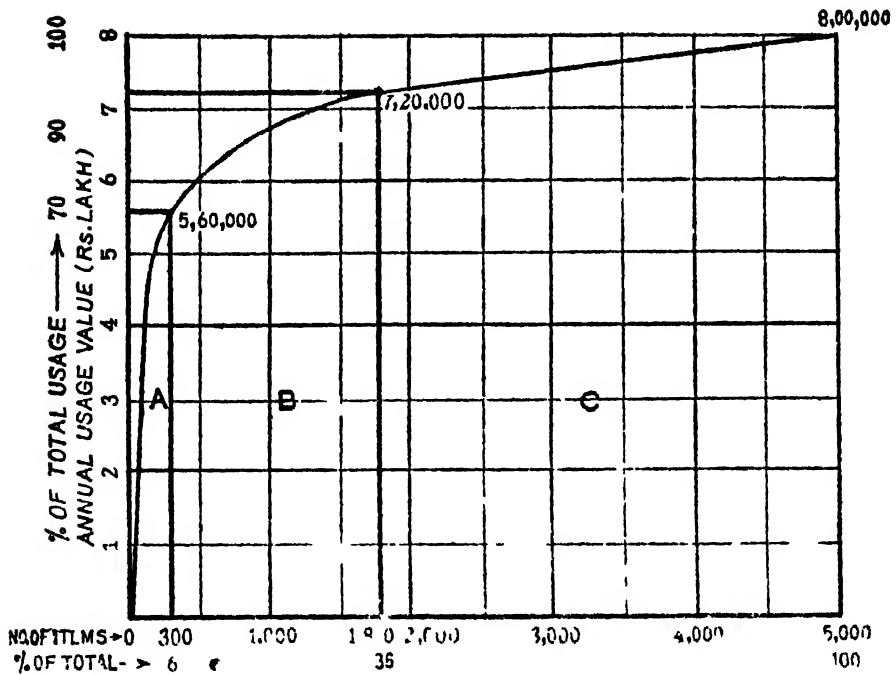


Fig 2.17 ABC Analysis

In the classification of the items, those that are critical in operation should be suitably taken care of. For instance, a small item of store which according to the above mentioned procedure of classification on the basis of consumption value falls in category C may be very important from the point of view of production in as much as its non-availability at a time may bring the production to a halt. On this consideration, the item should be placed in category A despite its low value. For such critical items, therefore, the stock-out cost should be an additional factor to be considered while classifying them.

Materials Issues (or Stores Utilization) Control. The next phase in the procedure for control of stores is the control in issues. Materials when required for consumption are issued to the departments concerned as per authorised quantity and under proper authority. The issues are priced and the values thereof charged to the costs of products. Any surplus or unwanted materials are returned by the departments to the Store and are properly accounted for. The control and accounting of issues may be termed Issues Control.

While issuing materials from Store, the basic principles followed are :

(i) *Planning of material requirement* : Standard or the allowable quantity should be fixed for each item of material required. The Bill of Materials (discussed in the following section) provides an exact statement of the quantity of the various items of materials required against a production or job order.

(ii) *Requisitioning of materials* : Materials are to be requisitioned on the authority of the bill of materials. The stores department should not issue material

in excess of standard or specified or allowable quantity. Whenever under special circumstances any excess material is required, a supplementary bill of materials should be issued under the orders of the competent authority. In some concerns, excess materials are drawn on Excess Materials Requisitions that have the same ruling as the materials requisition (Fig. 2.19) but are usually made out on paper of a different colour. The use of excess materials requisitions facilitates calculation of material usage variance where standard costing system is adopted.

(iii) *Issue of sundry materials* : Sundry materials (also known as consumable stores or simply, stores) may be required in the various departments for purposes other than for direct production orders. For these also, periodical requirements may be pre-determined or budgeted. Blanket or open orders may also be given by the responsible executives for the issue of material on 'as required' basis.

(iv) *Internal audit of issues* : The internal audit department (or the cost office functioning as such) should exercise concurrent checks over the drawal of materials. All excess issues detected in audit should be properly explained and accounted for.

(v) *Control of wastage* : Wastage should be reviewed in detail. In some processes, some wastage is inevitable but vigilance should be exercised while actually using materials and also by timely reporting, to ensure that actual wastage does not exceed the standard wastage fixed on the basis of technical data.

Bill of Materials (or Specification of Materials). A Bill of Materials (Fig. 2.18) is an itemised list of all materials required for a job, process, or service. It gives the details of materials necessary and the quantity of each item. Substitute materials that may be used when the original materials are not available, are also indicated in the bill of materials. As soon as an order is received, the bill of materials is prepared by the planning department with reference to the standardised specifications.

BILL OF MATERIALS						
No.:		Production Order No. :				
Date of issue :						
Department authorised :						
Item No.	Description of material	Quantity	For departmental use			Remarks
			Materials requisition No.	Date	Quantity demanded	

Fig. 2.18. Bill of Materials

The functions of a bill of materials are as follows :—

- (i) It serves the purpose of an advance intimation to all concerned, of the orders to be executed.
- (ii) Purchase requisitions are issued on the basis of the bill of materials. This enables the purchase department to take action for purchase so that materials are kept ready at the time of manufacture. Sometimes suitable columns are provided in the bill of materials to record the purchase requisitions and the purchase orders placed.
- (iii) A bill of materials is an authority for the production departments to place materials requisitions and no frequent back reference to the original drawing etc. is necessary every time a requisition is made out. The store-keeper will issue materials only if authorised in the bill. In some cases, materials are issued on the basis of bill of materials itself and materials requisitions are dispensed with.
- (iv) As an additional check, the accounts office may sometimes review the over-issue of materials, if any. Under-issues are also examined and a consistent under-issue would indicate the necessity for revising the provision made in the bill of materials. The bill of materials also helps the cost department to readily calculate the material cost of a job.

Materials Requisition. As a fundamental rule, no material is issued from the Store without a proper written authority. Requests for issue of materials should be made to the storekeeper in the prescribed form signed by the person demanding them. The document which authorises and records the issues of materials is known as Materials Requisition (also called Stores Requisition Note, Material Demand Note, or Material Authorisation). The contents of a materials requisition (Fig. 2.19) are :

(i) *Number and date of the requisition* : The materials requisitions are numbered in the serial order, centrally by the Stores Department. This provides a check to ensure that no requisition is left out in accounting. Besides the central number, the department placing the requisition may put its own serial number on it.

(ii) *Section demanding* : This indicates the place where the material is to be delivered.

(iii) *Particulars and code for the materials* : To avoid incorrect issues, full details regarding specifications, size etc. should be entered. Codes are necessary for mechanised material accounting.

(iv) *Authority for requisition* : This also indicates the purpose of drawal. If the requisition is for direct materials, the production order number of the job number is entered. Requisitions for indirect materials should indicate the relevant Standing Order Numbers.

(v) *Quantity demanded* : The quantity authorised (through bill of materials in the case of production orders) and the unit of measurement are entered in the requisition.

(vi) *Unit cost* : The rate at which the issue is to be priced is obtained from the stores ledger. The rate is worked out under one of the methods of pricing issues described later in this chapter.

Usually three copies of materials requisition are prepared : two copies are sent to the stores department for facilitating issue of the material, and one copy is retained by the indenting section as office copy. After issuing the material, the storekeeper allots a serial number in both the copies and enters therein the bin card/ledger folio number. He retains one copy for reference and posting in the bin card, and passes on the other copy to the cost office (stores control section) for pricing and store accounting.

A requisition may be for direct material or for indirect material. In order to distinguish at sight, requisition forms may be printed on papers of two different colours. A third colour may be used for Excess Materials Requisitions for materials required in excess of normal quantity or materials not properly authorised. Materials return notes, for which the same procedure as described above is followed, may be printed in another colour.

Copies of the materials requisition and return notes in possession of the cost office are priced by the stores ledger clerk in accordance with the pricing methods in use. The quantity and value of each transaction are then posted on a day-to-day basis, in the appropriate columns of the stores ledger and the balances are computed after each issue entry.

The requisitions are posted in a Requisitions Journal or Materials Consumed Summary. This is a memorandum book in columnar form to show the cost of direct and indirect materials consumed against the various production orders (including capital orders) or Standing Order Numbers. A form of such a journal is given in Fig. 2.20. Materials return notes may also be included in this journal.

At the end of the month or the week, as necessary, the columns of the journal are totalled and a summary is made showing the cost of materials chargeable to the various accounts. This summary forms the basis for journal entries shown below :

Journal entries :

For direct materials :

Dr. Work-in-Progress Account
Cr. Stores Control Account

For indirect materials :

Dr. Factory/Administration/Selling and
Distribution Overhead Control Account
Cr. Stores Control Account

When the number of stores classifications and production orders are numerous, requisitions may be analysed first by Stores Control Account and then by Production Orders and S.O. Nos ; group totals may then be journalised.

For indirect materials used for administration and selling and distribution divisions, the debits are made to the Administration Overhead Control Account and Selling and Distribution Overhead Control Account respectively. For materials returned to Store, the above entries are reversed.

Sometimes under the circumstances stated below, the quantity required cannot be definitely stated on the materials requisition since it is known only at a later stage :

(i) Small quantities that cannot be correctly estimated and where the quantity required can be known only later when the manufacture has sufficiently progressed.

(ii) Where the nature of the material is such that it can be issued in bulk only. For example, the whole length of a bar of metal is issued, out of which the production department cuts out the length required.

Date	Requisition No.	Department	Production/ Capital Order No or Standing Order No	Particulars	ISSUE				RETURNS		NET										
					Direct material	Indirect material	Indirect material	Direct material	Direct material	Indirect material	Direct material	Indirect material	Total								
Total																					
Debit Work-in-Progress :																					
Debit Factory overhead :																					
Debit Administration overhead :																					
Debit Selling and distribution overhead :																					
Debit Capital Order .																					
Credit Stores control account																					

Fig. 2.20 Requisitions Journal

(iii) For certain production orders, materials are issued in excess to cover wastage in production. Although the percentage of wastage is predetermined and issues made accordingly, the actual wastage may be more or less than the estimate.

In the above-mentioned cases, either of the following procedures may be adopted :—

- (a) No quantity is initially entered in the materials requisition. The requisition is kept pending with the storekeeper and released later for accounting, only when the quantity consumed is known.
- (b) Material in excess of requirement is issued. After production is completed, the surplus material is returned to store on a materials return note.

In certain industries, particularly process industries, it is not possible to directly determine the quantity of materials actually issued. The following alternative methods are available in such cases . —

1. *By stock-taking* : This is suitable where bulk materials are utilised for one purpose or in one process or department only. The quantity of each issue need not be measured but at frequent intervals, stock of the material in hand is taken. The difference between the opening stock plus the receipts, on the one hand, and the closing stock on the other, determines the quantity issued. A shortcoming of this method is that excess issues, if any, is revealed too late for remedial action.
2. *By estimating* : The quantity consumed for each production order or process is technically estimated. When several production orders or processes are involved, the consumption for each is determined by means of a formula or by suitable proration, e.g. ratio of quantity of the raw material to physical volume of production, ratio of raw material used to direct labour hours or direct machine hours of production, ratio of material cost to direct labour cost etc., calculated from past historical records. The quantity of assessed consumption is taken as the quantity issued. The method is, at best, a rough one and it conceals losses in handling, pilferage, etc. Final stock-taking may reveal heavy discrepancies between the book balances and the physical stock that need to be adjusted prorata on estimated quantity.

Materials Return Note. Situations arise when materials have to be returned from production departments to the Store. The following types of return may be necessary :—

- (i) Materials issued in bulk in excess of requirement.
- (ii) Scrap, waste and materials arising out of defective and spoiled work.
- (iii) Excess materials on account of reduction of a production order.
- (iv) Surpluses on account of excess provision in the bill of materials.

The return is made on a form, known as Materials Return Note, which records the return of unused materials. The form of the return note (See Fig. 2.21) is similar to that of a materials requisition but the two forms may be printed on

papers of different colours. The value of a return note is taken as a minus figure for accounting purposes.

MATERIALS RETURN NOTE					CR.	
Production order No. :		No. :				
Standing order No.		Date :				
		Department returning :				
Particulars	Code No.	Quantity	Unit of quantity	Cost		
				Rate per unit	Amount	
Authorised by	Received by	Bin card posted by	Stores ledger posted by	Priced by		

Fig. 2 21 Materials Return Note

A separate set of materials return notes may be used for returning scrap and defective material. These are termed *Scrap Return Notes* which except for the name, are the same as materials return notes.

Pricing of Material Issues. While valuation of receipts of materials does not present any particular difficulty as this relevant information is readily available, the position is not as simple in valuing issues. When issues are made out of various lots purchased at varying prices, the problem arises as to which of the receipt prices should be adopted for valuing the materials requisitions. The various methods used for the purpose are discussed below :

(i) *Specific Price Method (Identifiable Cost Method)*: When stores are purchased specifically for utilization against a particular job or production order or service order, e.g. major repairs or capital works or where issues can be identified with specific receipt consignments, the materials requisitions may be priced at the actual purchase price. This method can also be adopted if purchase prices are fairly stable, as for example, in the case of items covered by price control orders. Obviously, the method has only a limited application.

(ii) *First-in First-out (FIFO) Method*. The principle is that issues are priced in the order of the purchase lots. The price of the earliest consignment is taken first and when that consignment is exhausted, the price of the next consignment is adopted, and so on.

It is to be noted that physical issues of stores need not be in the above order as generally it is neither possible nor necessary to do so and this arrangement is only for the purpose of accounting. As materials purchased at earlier rates are charged off first, the value of the closing stock conforms, more or less, to the current market price. The chief *merit* of the system is that it is simple to operate. It is also useful where transactions are not too many and prices of the materials are

fairly steady. The method is particularly suitable for bulky materials with high unit prices.

Let us assume that the transactions during a month were as follows :—

Date	On Order		Receipt		Issue units	Balance units
	Qty.	Rate (Rs)	Units	Rate (Rs)		
1st			400	2.5		400
6th					200	200
8th			500	2.8		700
12th					300	400
15th			300	2.4		700
18th	500	2.6				
28th					500	200

(The above data will be taken to illustrate the other methods of pricing also, discussed in the subsequent paragraphs.)

Under the FIFO method, the issues will be priced as under :

6th	200	at	Rs. 2.5
12th	200	at	Rs. 2.5
	100	at	Rs. 2.8
	<hr/>		
	300		
28th	400	at	Rs. 2.8
	100	at	Rs. 2.4
	<hr/>		
	500		

The *objections* against this method are summarised below :

- The calculations become complicated and cumbersome if consignments are received very frequently at varying prices.
- For pricing one requisition, more than one price has often to be adopted.
- Cost may be distorted if the price of different lots of materials are used for pricing issues to different batches of production.
- In a fluctuating market, the effect of current market prices is not revealed in the costs of issues.

An example illustrating this method is given below :

EXAMPLE 2.9.

The following is an extract of the record of receipt and issue of Sulphur in a chemical factory during a month.

Feb.	1	Opening balance	500 tonnes @ Rs. 200/-
"	3	Issue	70 "
"	4	"	100 "
"	8	"	80 "
"	13	Received	200 " @ Rs. 190/-
"	14	Returned from department	15 "
"	16	Issue	180 "
"	20	Received	240 " @ Rs. 190/-
"	24	Issue	300 "
"	25	Received	320 " @ Rs. 190/-
"	26	Issue	115 "
"	27	Returned from department	35 "
"	28	Received	100 " @ Rs. 190/-

Issues are to be priced on the principle of 'First-in First-out'. The Stock verifier has found a shortage of 10 tonnes on the 22nd, and left a note accordingly. Draw up a priced store ledger card for the material showing the above transactions.

(I. C. W. A., Inter)

ANSWER :

PRICED STORES LEDGER

Description : *Sulphur* Stores Code No. 02/3041/1
 Specification : *Crystalline, Commercial* Unit of quantity : *Tonnes (04)*
 Normal source of supply : *Local* Location : *Godown III*
 Normal lead time : *15 days*

Date	Voucher No.	Source Receipt or Issue	Quantity			Value		
			Receipt	Issue	Balance	Receipt	Issue	Balance
1		Balance				Rs.	Rs.	Rs.
3		Issue			500			1,00,000
4		Issue		70	430		14,000	86,000
8		Issue		100	330		20,000	66,000
13		Issue		80	250		16,000	50,000
13		Receipt	200		450	38,000		88,000
14		Return from Dept.	15		465	3,000		91,000
16		Issue		180	285		36,000	55,000
20		Receipt	240		525	45,600		1,00,600
22		Deficiency (Issue adjustment)		10	515		2,000	98,600
24		Issue		300	215		15,000	
							42,750	
							57,750	40,850
25		Receipt	320		535	60,800		1,01,650
26		Issue		115	420		21,850	79,800
27		Return from Dept.	35		455	6,650		86,450
28		Receipt	100		555	19,000		1,05,450

Note : The deficiency of 10 tonnes found on stock verification has been written off as stores issue at the earliest available rate.

(iii) *Last-in First-out (LIFO) Method* : In this method, pricing of issues is made in the reverse order of purchase, i.e. by adopting the price of the latest available consignment. As the method applies the current cost of replacing the material to the cost of units except when the purchases were made long ago, it is also sometimes known as the *Replacement Cost Method*.

This is a comparatively recent method, best workable with the Base Stock method, described later. Assuming the same figures that were taken for the purpose of illustrating the FIFO method, the issues will be valued as shown below :

6th	200	at	Rs. 2.5
12th	300	at	Rs. 2.8
28th	300	at	Rs. 2.4
	200	at	Rs. 2.8
	<hr/>		
	500		

The *merits* of this system are as follows :—

- Like the FIFO system, this is simple to operate and is quite useful where transactions are not too many and the prices are fairly steady or are rising. This is also particularly suitable for bulky materials with high unit prices.
- Reasonably correct effect of current market prices is reflected in the cost of sales provided the stores are recently purchased. In a fluctuating market, quotation of prices for the company's products is more safe than in the other methods.

The *objections* against this method are summarised as follows :—

- As in the FIFO system, calculations become complicated and cumbersome when rates of receipts are highly fluctuating.
- Sometimes more than one price has to be adopted for pricing a single requisition.
- As in the case of FIFO method, costs of different batches of production are distorted.
- During falling markets, issues are priced at lower rates and materials in stock purchased at higher rates should require adjustment to a lower value, on the principles of valuation of stock at the 'lower of the cost and market price'.
- The contention that the effect of the current market price is shown in the cost of sales may not be always correct, e.g. when there is a change in the market price after last purchase or if the previous issue transactions have already consumed the latest receipts.
- Being dependent on the latest receipt rates, the work of pricing issues may be held up if the receipt rate is not easily available. This difficulty may, however, be obviated by pricing the receipt and issue transactions provisionally and adjusting subsequently when the actual price is known.

(iv) *Average Price Method* : The pricing of issues under the three methods discussed above are on the basis of actual or exact cost. The average price method

differs from these methods in that it adopts as its basis, average cost instead of exact cost. This method is suited for items of small values and also when the transactions are numerous and there is a heavy fluctuation in the purchase price. Under this method, sharp price fluctuations are smoothened and movement of the issue price, whether upward or downward, is gradual.

The following methods of averaging issue price are in use :—

- (a) Simple average method
- (b) Periodic simple average method
- (c) Moving simple average method
- (d) Weighted average method
- (e) Periodic weighted average method
- (f) Moving weighted average method

(a) *Simple Average Method* : The prices of the receipt lots are averaged regardless of the quantity in each. This average price is adopted for pricing issues till another consignment is received when again, a fresh average price is calculated. Thus, a new average rate is worked out after every receipt. The rate is also revised when an earlier consignment the price of which was taken into consideration for arriving at the average rate is exhausted. The following example will illustrate this. Taking the figures assumed earlier, the issues under this method will be :

6th	200	at	Rs. 2.5
12th	300	at	Rs. 2.65 $\left(\frac{\text{Rs. 2.5} + \text{Rs. 2.8}}{2} \right)$
28th	500	at	Rs. 2.6 $\left(\frac{\text{Rs. 2.8} + \text{Rs. 2.4}}{2} \right)$

(It may be noted that the opening balance on the 28th, i.e. before the issue of 500 units does not contain any quantity priced at Rs. 2.5).

The method is suitable where materials are received in uniform lot quantities. If the quantity in each consignment varies widely, the average price will lead to erroneous costs. For example, if a consignment of 5,000 kgs. of a material is purchased at Re. 1 per kg. and the next consignment of only 10 kgs. at Rs. 5 per kg., the average rate of Rs. $(1 + 5)/2 = \text{Rs. 3}$ per kg. will not be realistic.

(b) *Periodic Simple Average* : The method is similar to the one described above except that the average rate is calculated periodically, say every month, instead of after every receipt transaction. The average of the unit prices of all the consignments received during a month is adopted as the rate for pricing issues during the subsequent month, as shown below :

$$\text{Periodic simple average rate} = \frac{\text{Rs. 2.5} + \text{Rs. 2.8} + \text{Rs. 2.5}}{3} = \text{Rs. 2.6}$$

This method suffers from the following *disadvantages* :—

- (i) Pricing of issues at the last month's rate ignores possible heavy fluctuation of the price of a material during the current month.
- (ii) Like the simple average method, this is also not an exact cost method. Valuation of stock may become erroneous and sometimes fictitious balances of material values such as quantity without value or minus value, or value without quantity may be shown.

- (ii) Heavy clerical work may be involved at the end of the accounting period because issue rates for all the items have to be worked out at a time.

(c) *Moving Average Method*: In this method, the periodic simple average prices are further averaged. The total of the periodic average prices of several specified periods is divided by the number of periods taken. The periods selected include the period in which the material to be priced is issued. The method is illustrated below with the help of two examples: one example relates to a case where purchase prices are rising, and the other to a case where the prices are falling. The period adopted for averaging is six months. (It may be noted that the illustration is equally valid in the case of moving weighted average prices.)

Month	A. Rising prices		B. Falling prices	
	Periodic average price	Moving average price	Periodic average price	Moving average price
	Rs	Rs	Rs	Rs
January	2 45		2 45	
February	2 62		2 40	
March	2 80		2 38	
April	2 82		2 35	
May	2 85		2 30	
June	2 90	2 74	2 26	2 36
July	2 92	2 82	2 25	2 33
August	2 95	2 87	2 20	2 29
September	3 00	2 91	2 10	2 25
October	3 05	2 95	2 00	2 19

It will be seen from the foregoing table that when prices are rising, the issue price worked out is lower than the periodic average prices for the period concerned. The position is reversed when prices are falling. This results in a material loss or profit and like the other two simple average methods, the closing stock is either under-valued or over-valued.

Simple average systems are useful when prices are fairly stable or where the consignments are received in standard sized lots having the same quantity in each.

(d) *Weighted Average Method*: In this method, the quantity of each lot of receipts is also taken into account for calculating the unit price of issue. The aggregate of the products of the quantity and price of each lot divided by the total quantity of all the lots determines the unit price. This is worked out after every receipt. Assuming the same data as used for illustrating the previous methods, the weighted average rate will be calculated as follows:—

6th	200	at	Rs 2 5	
12th	300	at	Rs 2 71	$\left(\frac{200 \times 2.5 + 500 \times 2.8}{200 + 500} \right)$
28th	500	at	Rs. 2 58	$\left(\frac{400 \times 2.71 + 300 \times 2.4}{400 + 300} \right)$

The major disadvantage of this method is that a considerable amount of clerical work is involved for frequent calculations of the rates. When, however,

the price and quantity of the various receipt consignments are liable to vary widely, the weighted average method is very useful.

(e) *Periodic Weighted Average Method*: As in the preceding method, the issue rate is worked out by taking the quantity and the price of each lot of receipt but instead of computing the rate after each receipt transaction, this is done only periodically, usually at intervals of one month. The rate worked out in this manner is applicable for issues made in the subsequent month or in the same month, as illustrated below :

$$\text{Periodic weighted average rate} = \frac{\text{Rs. } 1,000 + \text{Rs. } 1,400 + \text{Rs. } 720}{400 + 500 + 300} = \text{Rs. } 2.6$$

The method has the following particular *advantages* :—

- (i) As with the periodic simple average method, clerical costs are reduced.
- (ii) The method is useful in process costing. The interval at which rates are revised should coincide with the process accounting period.
- (iii) The issue rate is not affected by short-term fluctuations in price.

The *shortcomings* of the method are as follows :—

As in the case of the periodic simple average system,

- (i) heavy clerical work at the end of the accounting period is involved, and
- (ii) violent fluctuations of purchase prices are ignored till the end of the period.

Like all other average methods, this method gives rise to accounting losses and profits leading to erroneous valuation of closing stock, and there may be residual plus or minus value balances when the closing balance of quantity is nil.

(f) *Moving Weighted Average Method*: This method is similar to the moving average method. The issue rate is calculated by dividing the sum of the periodic weighted average prices for a number of periods by the total number of such periods.

(v) *Standard Price Method*: In this method, the price of issues is predetermined for a stated period taking into account all the factors affecting price such as anticipated market trends, transportation charges, and normal quantity of purchase. Standard prices are determined for each material and materials requisitions are priced at standards irrespective of the actual purchase price. Any difference between the standard and actual prices of purchase results in material price variance. Fixation of price standards is one of the requisite steps to be taken where standard costing system is introduced. Even where standards have not been fixed or cannot be fixed, it may be possible to adopt estimated prices to serve as standards on a short-term basis. Where, for instance, prices of materials fluctuate heavily, it is not practicable to fix standard prices on a long-term basis. In such cases, standards are computed for short periods only and modified frequently, as necessary.

The method has all the advantages attributable to the standard cost system (discussed in a later chapter). Special mention might be made here of two main advantages, viz. simplification in accounting resulting in reduction of clerical expenses, and the ease with which the efficiency or otherwise of the purchase organisation can be determined.

(vi) *Base Stock Method* : This is not an independent method of pricing issues. The method is based on the principle that only a portion of the stores moves and a core is always maintained in stock. This core or base stock represents the minimum balance of the material and is computed on an estimated basis for each item. The base stock is valued usually at the lowest purchase price and the moving portion of the store over and above the base stock is priced under any of the methods described above.

(vii) *Highest-in First-out (HIFO) Method* : This method assumes that the closing stock should always remain at the minimum value and so the issues should always be made at the highest value of the receipts. The method is not popular but is mainly used in case of monopoly products or 'cost plus contracts'. It always undervalues the stock which is tantamount to creating a secret reserve. The issues (assuming the previous data) under this method will be :

6th	200	at	Rs. 2.5
12th	300	at	Rs. 2.8
28th	200	at	Rs. 2.8
	100	at	Rs. 2.5
	200	at	Rs. 2.4
<hr/>			
500			

(viii) *Market Price Method* : Under this method, the market price is adopted as the basis for pricing the issues. The term market price is liable to various interpretations. It may mean the last purchase price, expected market price if purchased now, purchase or quotation price on the date of issue, net realisable value, or the replacement price of purchase at a later date.

The market price method is useful for pricing of issues of obsolete stores and items that have been lying in stock for long periods in which case the net realisable price should be adopted as the issue price. Another important feature of the method is that if issues are priced at current market rates, price reduction, if any, on account of advance purchases in bulk is not reflected in the cost of sales.

The market price method is not considered to be accurate and although the latest material prices are included in costs, elements of estimate and uncertainty are introduced. It also involves extra clerical labour for maintaining elaborate records of the latest prices of a large number of items. With a little more effort, the concern may as well switch over to the standard cost method.

(ix) *Next-in First-out (NIFO) Method* : Under this method, the issue price is taken as the price of the next consignment of materials that is still to arrive and is yet to be brought on charge. The purpose is to adopt a rate of issue as near as possible to the current market rate. In this respect, it is similar to the market price method discussed in the earlier paragraph but is more simple to operate since the price of the next consignment due is readily available in the purchase order. Problem, however, would arise if the price committed in the purchase order is changed at the time of actual payment after the receipt of the consignment due to any escalation clause or otherwise.

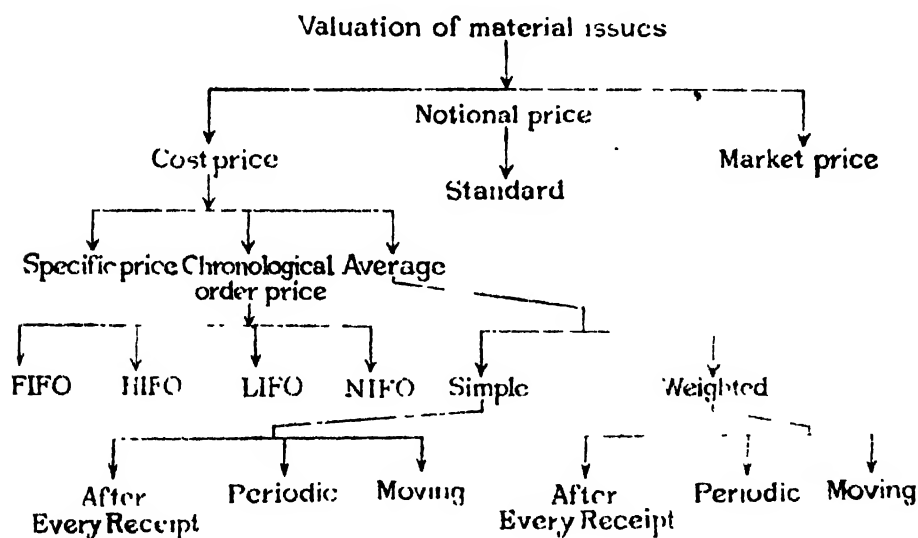
Assuming the earlier data, pricing under this method will be :

6th	200	at	Rs. 2.8
12th	300	at	Rs. 2.4
28th	500	at	Rs. 2.6

The method is not in much use as it is complicated and suffers from the same disadvantages as the LIFO, FIFO and HIFO methods, viz. that the costs of different batches of production are not comparable.

(x) *Inflated (or Reduced) Price Method* : Issues are sometimes made at inflated or reduced prices to cover loss or gain in the quantity of material. This has been discussed in the section dealing with the accounting of surpluses and deficiencies found on stock taking. In fact, this is not a distinct method of pricing issues but a procedure for accounting adjustment.

Summary of Pricing Methods. The various methods described may be classified and tabulated as follows : —



The particular method of pricing stores issues adopted in a business will depend on the following factors :—

- (i) Type of costing system, i.e. job or process cost, in use.
- (ii) Degree of accuracy required.
- (iii) Frequency of receipt and issue transactions.
- (iv) Fluctuation in purchase price.
- (v) Whether issues can be identified with purchase lots.
- (vi) Ease with which the method selected can be operated : the clerical expenses involved.
- (vii) Policies regarding valuation of closing stock. (Each method causes a different value for the stock.)
- (viii) Whether standard costing system is in vogue.
- (ix) Whether the concern participates in a scheme of uniform costing.

A practical illustration showing the different results obtained from the

various methods of pricing may be seen in Fig. 2.22. Another example is given below :

EXAMPLE 2.10.

Six units of an item of stores were purchased in the following order :—

Lot 1 (3 units) A_1 , A_2 , and A_3 , at a price of Rs. a each

Lot 2 (2 units) B_1 , and B_2 , at a price of Rs. b each

Lot 3 (1 unit) C at a price of Rs. c each

Three issues of two units each are made

Show formulae for four different methods based on actual prices for pricing the issues when,

(a) all issues are made after the receipt of the third lot, and

(b) an issue is made after the receipt of each lot. (*I. C. M. A., Part II—Adapted*)

ANSWER :

RECEIPT

	Rs.	Rs.
1st lot (A_1 , A_2 , A_3)	$3 \times a = 3a$	
2nd lot (B_1 , B_2)	$2 \times b = 2b$	
3rd lot (C)	$1 \times c = c$	

ISSUES

I. FIFO Method

	After third lot	After each lot
1st issue	$2 \times a = 2a$	$2 \times a = 2a$
2nd issue	$1 \times a$	$1 \times a$
	$1 \times b = a + b$	$1 \times b = a + b$
3rd issue	$1 \times b$	$1 \times b$
	$1 \times c = b + c$	$1 \times c = b + c$

II. LIFO Method

1st issue	$1 \times c$	
	$1 \times b = c + b$	$2 \times a = 2a$
2nd issue	$1 \times b$	
	$1 \times a = b + a$	$2 \times b = 2b$
3rd issue	$2 \times a = 2a$	$1 \times c$
		$1 \times a = c + a$

III Simple Average Method

1st issue	$\frac{a+b+c}{3} \times 2^*$	$a \times 2$
2nd issue	—do—*	$\frac{a+b}{2} \times 2$
3rd issue	—do—*	$\frac{b+c}{2} \times 2$

IV. Weighted Average method

1st issue	$\frac{3a+2b+c}{6} \times 2^\dagger$	$\frac{3a}{3} \times 2$
2nd issue	—do—*	$\frac{a+2b}{3} \times 2$
3rd issue	—do—†	$\frac{b+c}{2} \times 2$

(*In effect, this is the result obtained under the periodic simple average method also if it is assumed that only these three lots were received during the period.)

(†If we assume that only three lots were received during a period, the prices obtained will be the same in the periodic weighted average method)

				F.I.F.O. Method					Standard Price Method					
Date	Receipts			Issues			Balance		Issues			Balance		
	Quantity	Rate Rs.	Value Rs.	Qty.	Rate Rs.	Value Rs.	Qty.	Value Rs.	Qty.	Rate Rs.	Value Rs.	Qty.	Rate Rs.	Value Rs.
Jan. 3	200	2.00	400.00				200	2400.00				200		400.
.. 5	250	2.20	550.00				200	2950.00				450		950.
							250	2						
							450							
				200	2.00	400.00								
.. 8				100	2.20	220.00								
				300		620.00	150	2317.00	300	2.20	660.00	150		290.0
.. 10	100	2.30	230.00				150	2547.00				250		520.0
							100	2.						
							250							
.. 20	400	2.00	800.00				150	2.347.00				650		1320.0
							100	2.						
							400	2.						
							650							
				150	2.20	330.00								
.. 25				100	2.30	230.00								
				250		560.00	400	229.50	250	2.20	550.00	400		770.0
.. 31	100	2.50	250.00				400	2.1						
							100	2.79.50				500		1020.
							500							
Feb. 1														

② The entire balance has been shown to be issued at

* The weighted average issue rate on the 31st after adoption of rate correct up to two decimal places only This difference is charged to overhead

** The Value of the balance 500 units at the standard is valued

Pricing of Returns. Materials returned to Stores from production departments on materials return notes are entered in the respective bin cards and in the stores ledger, either as receipts or as 'minus issues'. The returns may consist of materials in the same condition in which they were originally issued or of scrap, waste, defective, and spoiled materials arising in course of production. Materials returned in the original condition may be valued under one of the following methods :—

- (i) *At the same price at which issued :* The price is obtained from the original materials requisition. As the values of the credit and the original debit to the production order concerned are identical, no further adjustments are required. The returned materials are set apart and at the time of next issue they are priced at the original price. A variant of this method is to treat the return as a new purchase (but priced at the original price) and to post the transaction in the bin card and stores ledger after the last purchase entry. If the average method of pricing issues is in use, the average rate is calculated after each return.
- (ii) *At the current price of issue :* The same method which is used for pricing the issue is adopted for pricing the return, i.e. the return is priced at the rate at which any materials requisition placed on that date would have been priced. Although this method avoids keeping track of the original requisitions and simplifies clerical work, difficulty is experienced if many transactions take place during the period intervening the original issue and the return. If in the meantime the pricing rate has changed, excess or less credit would be given to the production order against which the material was originally drawn. This method is not, therefore, popular.

Scrap, waste, etc. do not possess the same value as the original material and on return from the production department, these are taken on charge on separate bin cards, a bin being set apart for each category of scrap. A price is fixed for each category and the returns are priced accordingly. The method of pricing of scrap etc. is dealt with in Chapter 8.

Transfer of Materials. Materials issued for one production order or for one shop or department are often utilised for another. This happens when materials are issued in bulk against one particular job though they may be required for several jobs. In some cases, materials issued may have to be diverted for other jobs, if the needs of the latter are more urgent. As a normal procedure, transfer of materials from one job to another should be avoided, as far as practicable. This is to obviate unauthorised transfers, manipulations and malpractices in material consumption, and errors in material accounting due to incorrect transfers or omissions of transfers. Any material not required for a job should be returned to the store on materials return notes and then re-issued to the next job. This is, however, not always possible and the procedure, if rigidly followed, involves delay and unnecessary expenditure on the movement of the material to and from the store. In such cases, transfers are made on a document known as *Materials Transfer Note*, a form of which can be seen in Fig. 2.23. The materials transfer

MATERIALS TRANSFER NOTE								Date :
								No :
						Credit		
						Production Order No./ Job No./ Standing Order No.		
						Department		
						Store		
						Particulars		
						Quantity		
						Unit rate		
						Amount		
						Production Order No / Job No / Standing Order No		
						Department		
						Store		
Authorised by								
Received by								
Priced by.....								

Fig. 223. Material Transfer Note

note records the transfer of material from one store, cost centre, or cost unit to another. Valuation of materials transfer note is done at the original price of issue but if this is not practicable, the current stores ledger rate is adopted for valuation as in the case of materials return notes. No entries in financial or cost ledgers are necessary unless the transfer is made between a direct order, a capital order and an overhead order, in which case the total amount for the month or week is debited or credited to the Work-in-Progress or Capital Order or Overhead Control Account with a contra entry in any of these accounts concerned.

Materials Issue Analysis. At the end of the month (or week, if weekly accounts are prepared), all the materials requisitions, return notes, and transfer notes pertaining to the month are collected and sorted according to departments or cost centres, and production orders or Standing Order Numbers on a document known as *Materials Issue Analysis Sheet* (Fig. 2.24) which, for cost accounting purposes, is a classified record of materials issues, returns, and transfers. The materials issue analysis provides totals for posting to the Stores Control Account. The sub-totals against direct orders, indirect orders, and cost centres are posted to the various control accounts. It will thus be seen that materials issue analysis also serves the purpose of the requisitions journal (see Fig. 2.20). Being a duplication of work, the journal may as well be dispensed with.

It is necessary to prove the entries in the stores ledger with the totals posted in the Stores Control Account. The receipt and issue entries made on a day-to-day basis in the various stores ledger folios are listed on a sheet and the total for the month or the week is arrived at. These totals are then agreed with the totals in the materials issues analysis and with the total amounts debited or credited to the Stores Control Account. The opening and the closing balances in each ledger sheet are extracted, totalled, and reconciled with the opening and closing balances in the Stores Control Account.

The next step in the accounting of issues of materials is to compile the direct and indirect material costs against each Production Order or Standing Order Number, as the case may be. In the process cost system, a department is usually synonymous with a process and the distinction between direct and indirect materials also sometimes vanishes. The amount appearing against a process order or a department in the materials issues analysis is posted to the cost sheet as the direct material cost. In the case of job costing, the amount is posted to the job cost sheet as direct material cost of the job. The accounting of the indirect material cost is dealt with in Chapter 4.

Adjustment of Unusual Balances in the Ledger. Unusual balances of the nature mentioned below often appear in the stores ledger. These are caused by incorrect posting or non-posting of documents and also because of the pricing of issues at average rates. After tracing the cause, the error is corrected and all transactions subsequent to the entry that gave rise to the unusual balance are adjusted. Minor differences may be adjusted to overhead through Stores Adjustment Account, as shown below :

- (i) *Plus quantity, nil or minus value* : The quantity in hand should

have the correct value at the latest rate and, therefore, the difference is cleared through Stores Adjustment Account.

- (ii) *Nil quantity, plus or minus value* : When there is no balance quantity in stock, the value is wiped out by debit or credit to the Stores Adjustment Account.
- (iii) *Minus quantity* : This is obviously an error due to a receipt not having been posted or posted incorrectly, or due to a double or incorrect posting of an issue transaction. The errors should be located and set right.

MATERIALS ISSUE ANALYSIS SHEET						
Period.....						
Production Order No./ Standing Order No./ Capital Order No.	Materials Requisition No /Materials Return Note No /Transfer Note No	Stores ledger Folio No	Quantity	Rate	Amount	Progressive total for each Order No.
Total						

Fig. 2.24. Materials Issue Analysis Sheet

Note : Amount credited to an Order No. is to be shown as negative figure or in red ink.

The Journal entries for adjustment against (i) and (ii) will be :

Dr. Stores Control Account
Cr. Stores Adjustment Account

(To adjust plus quantity and nil or minus value, and nil quantity and minus value)

Dr. Stores Adjustment Account
Cr. Stores Control Account

(To adjust nil quantity and plus value)

Summary of Accounting Procedure. The flow chart given in Fig. 2.25 summarises the accounting procedure used for materials.

Inventory Control. As stated earlier, inventory is comprised of stocks of materials, components, work-in-progress, and finished products. Inventory is built up by spending money, first on the procurement of raw materials, components and parts and then on labour and overheads to process these materials into finished goods. On the other hand, sale of goods and disposal of scrapped material result in reduction of inventory. The main objective of inventory control is to achieve maximum efficiency in production and sales with the minimum investment in inventory.

For an effective inventory control system, the following principles are kept in view :—

1. Sales are to be correctly forecast.
2. Production schedule should be properly forecast and laid out.
Forecast of sales and production would assist in efficient purchasing and investment in materials and for controlling production inventory.
3. Suitable procedures should be laid down to guide managers in performance evaluation and decision making.

The techniques commonly applied for inventory control are :

- (i) ABC analysis
- (ii) Setting of various stock levels
- (iii) Establishment of system of budgets
- (iv) Use of perpetual inventory records and continuous stock verification
- (v) Economic order quantity
- (vi) Provisioning and purchase procedure
- (vii) Review of slow and non-moving items
- (viii) Use of control ratios, e.g. Materials consumed/Average inventory (Inventory Turnover), Slow moving stores/Total inventory, Total inventory/Cost of production, Cost of sales/Average finished goods inventory, etc.

The levels of stock to be maintained for work-in-progress and finished goods depend mainly upon the demand for the products and the capacity of the plant. Shortage of finished goods may be caused by (i) deliberate stoppage or slowing down of production due to lack of market for the product or

FLOW CHART SUMMARISING MATERIALS ACCOUNTING PROCEDURE

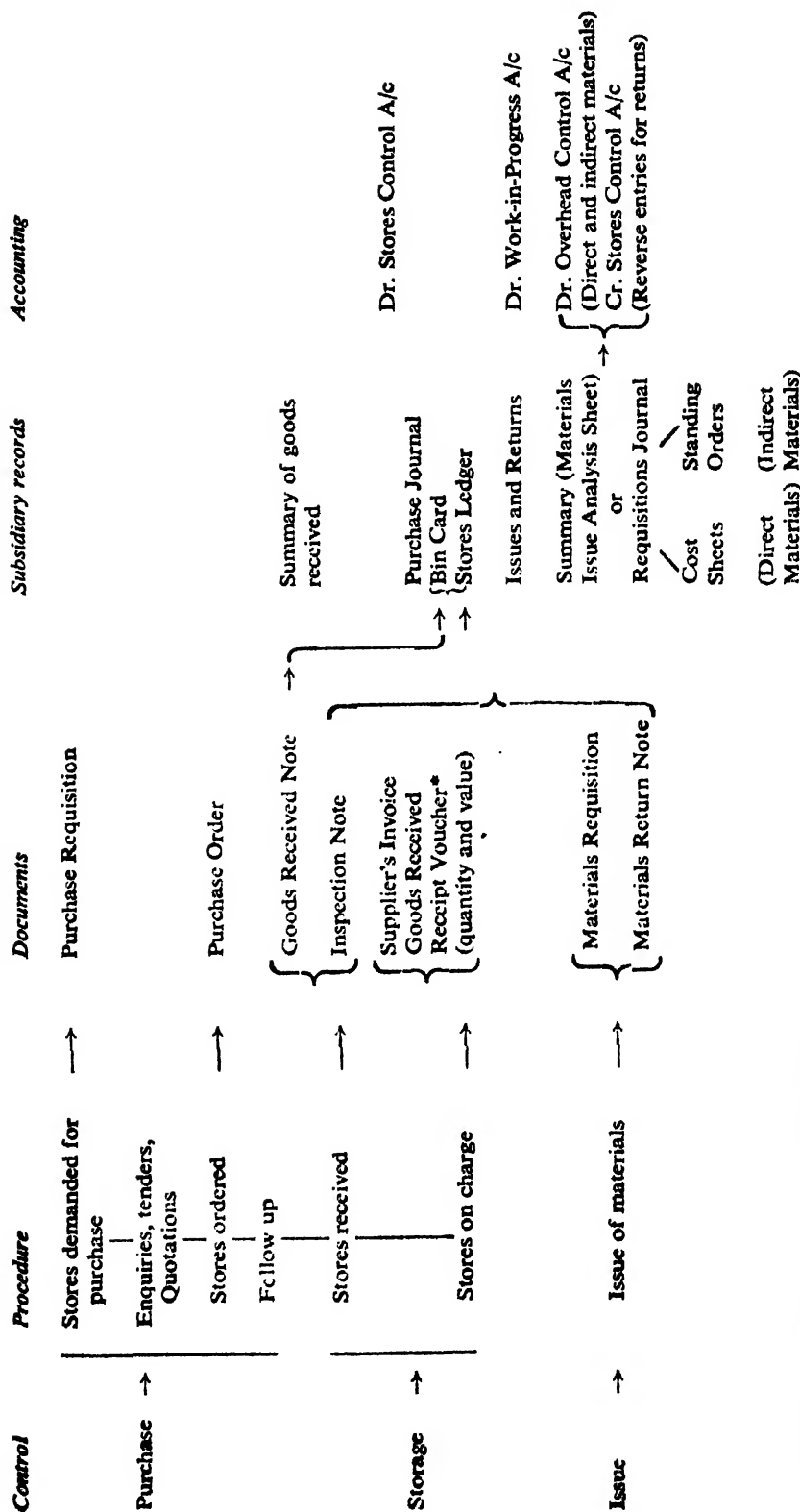


Fig. 2.25. Materials Accounting Procedure

*If prepared in addition to Goods Received Note.

(ii) nonavailability of enough production capacity. While the former situation may result in idle labour, machines, and other resources, the latter situation involves loss of sales and the corresponding profits, loss of business goodwill, and sometimes extra expenditure in the shape of overtime work and extra-shift work if quick and sudden attempts are made to improve the stock position. On the other hand, overstocking would, besides locking up of capital, result in losses due to deterioration and obsolescence of products and likely fall in their future prices.

Work-in-progress is slightly difficult to control. The stock of work-in-progress depends upon the number and sequence of the processes and subassemblies and the length of the production cycle. A system of efficient budgeting and proper production planning would assist in maintaining an uninterrupted flow of work, in reducing the length of the production cycle and ultimately, in optimising the work-in-progress inventory.

Accumulation of stock over time is another area that needs the attention of the management and reduction of surplus stock is one of the essential requirements of effective inventory control. The factors that tend to increase inventory are numerous. Some of these are :

- (i) Product diversification.
- (ii) Inefficient purchase organisation. Rush purchases may be made with the result that the materials on regular demand become surplus when received.
- (iii) Strict production schedule or non-effective planning so that actual production always trails behind the target, resulting in excessive stocking of raw materials, components, and work-in-progress.
- (iv) Economic batch quantity having not been established.
- (v) Long production cycle.
- (vi) Ineffective control on issues and consumption. Excessive wastage and spoilage require more stock.
- (vii) Absence of a suitable system of classification and codification.
- (viii) Increase in the market price.
- (ix) Reduced or slow sales.
- (x) Non-existence of research for simplification and standardisation of products.
- (xi) In assembly type of industries, the manufacture or purchase of components is not sometimes properly linked with the requirements of sub-assembly and final assembly with the result that stock of surplus components continue to grow.
- (xii) Management policy.

The specific factors leading to excessive stocking in a concern should be critically examined and suitable measures taken in a manner as demanded by the particular situation.

EXAMINATION QUESTIONS

1. Describe briefly the functions of the following departments with regard to stores control. (a) Stores Purchase (b) Stores and (c) Production.
(I. C. W. A., Inter)
2. As Financial Controller to a large manufacturing organisation, suggest a satisfactory plan for measuring the efficiency of the Purchase Department. Discuss the factors to be taken into consideration in determining the purchase efficiency and suggest a form of efficiency record summarising the Purchase Department's cost to the company and the job it has done.
(I. C. W. A., Final)
3. The proprietors of All-in-One, a leading Departmental Store find it difficult to provide adequate funds for the purchase of a wide range of products they are dealing in especially because of inflationary trends and restrictions on borrowings from Banks. As a Cost Accountant, you observe that there is no well-defined procedure for deciding the appropriate quantities of various products to be brought. Write a suitable report outlining the scientific procedures to be followed for ensuring efficient buying within the limited financial resources and without hampering sales.
(I. C. W. A., Inter)
4. Enumerate the points you would include in a report relating to the supply of materials when preparing a planned output programme.
(I. C. W. A., Inter)
5. (a) What are the different stock levels for standard items of stores used in a large manufacturing organisation? State how these levels are fixed.
(b) Give examples of such levels fixed in any industry you know of and indicate the use made of these levels.
(c) State the circumstances under which stock levels cannot be fixed.
(I. C. W. A., Inter)
6. The Managing Director of the Esmeralda Corporation paid a surprise visit to the stores department and verified by a series of sample checks that the physical stocks reconcile with the balances as shown in the stores ledger. He further ascertained from Cost Accounts Department that the total value of inventory on that date was Rs. 15,60,000. From the Production Control Department, he learnt that the average monthly consumption of materials was Rs. 4,50,000 and the Controller of Purchase assured him that materials could be obtained in desired quantities within a period of 5 to 6 weeks. Do you believe that the Managing Director was happy with the state of affairs as disclosed in the Stores Department? Give reasons.
(I. C. W. A., Inter)
7. What is the prime objective of material control? It is said that in any system of material control there are always two counteracting or opposing factors. What are these and why do these factors arise?
(I. C. W. A., Inter)
8. What is meant by 'economic order quantity' and what factors shall be considered in determining the size of an economic order? Illustrate with an example.
(I. C. W. A., Final)
9. In the process of inventory control, it is necessary to have minimum financial involvement without impairing production for want of an item and at the same time, avoiding accumulation of unwanted and obsolete stocks, which occupy valuable warehousing space which could be more profitably utilized otherwise.
List the effective steps to be taken for the effective inventory control procedure to achieve the above purpose and state how as an auditor you would verify the same.
(I. C. W. A., Final)
10. As a newly appointed Cost Accountant, you observe the following routine adopted in the factory. Do you approve? If not, suggest alternative procedures.
(a) All stores are received and passed into Stores by the storekeeper who enters the bin cards and the stores ledger.

- (b) All invoices are received by the storekeeper who records the value in the stores ledger and passes the invoice for payment.
 - (c) All stores required for manufacturing purposes are taken by the departmental foreman from the Stores and requisitions are issued for the quantity used, returning the unused quantity.
 - (d) If the stores are not in stock, the storekeeper or the departmental foreman purchases them from the local dealers. *(I. C. W. A., Inter)*
11. Frame instructions to stock-taking personnel as to the procedure for taking year end stock. This will include stores, raw and finished, and work-in-progress. Your answer should be in the form of a memorandum to the persons concerned.
What special arrangements would you make for goods received but not inspected and how would you control the despatch of finished goods during the stock-taking period? *(I. C. W. A., Final)*
12. What do you understand by ABC analysis of inventory ? What are the advantages derived from such an analysis? Indicate how such an analysis may be made for 2 lakh items of stores valued Rs. 20 crores held by an industrial undertaking. *(I. C. W. A., Inter)*
13. Mention the purpose served by Bill (or Specification) of Materials in (a) Stores, (b) Production and (c) Accounts Department. *(I. C. W. A., Inter)*
14. A factory operates a system of quantitative control on principal raw materials issued to production. It is found that a similar system is not practical for the control of consumable and maintenance stores, spare parts, small tools, etc. because of the very large number of materials involved. What system would you recommend which would ensure reasonable control on the usage of these materials? *(I. C. W. A., Inter)*
15. In nearly every industry there are certain classes of material which are required in small quantities or in quantities which cannot be determined in advance ; consequently it is not possible to requisition them in quite the same manner as other materials. What in your opinion, is the simplest way to deal with the requisitioning and issuing of such materials from stores? *(I. C. W. A., Inter)*
16. Explain with examples the following methods of pricing issues of materials, (a) FIFO, and (b) LIFO.
Under conditions of rising prices which of these methods would you recommend and why? *(I. C. W. A., Inter)*
17. In a manufacturing concern the raw materials constitute high percentage of the cost of the finished product. In a period of steady increase in the price of raw materials, discuss the pros and cons of adopting the pricing methods of FIFO and LIFO for material issues. Suggest any other better method. Give reasons. *(I. C. W. A., Inter)*
18. A factory holds an inventory of 40,000 items. The items are partially indigenous and partially imported. Purchases are made from various vendors on the basis of comparative quotations and the prices vary frequently. Recommend a suitable method for pricing the issues. Indicate two other methods of pricing issues and state why these other methods are not suitable in this case. *(I. C. W. A., Inter)*
19. You are requested by your works manager to price all materials issued for production at replacement costs. Do you feel that such a procedure is correct or would violate all accepted accounting principles? Discuss the validity of the procedure stating the circumstances. *(I. C. W. A., Final)*
20. In times of rising or falling prices the financial statement sometimes results in a confusion between the marketing and the real operating profits or losses. Examine the merits of the Base Stock and the LIFO methods of inventory keeping in mitigating this confusion in the statements. *(I. C. W. A., Final)*
21. You are asked by your management to investigate and report, if there is any over investment of capital in raw materials. Illustrate your report using your own figures for any industry with which you are familiar. *(I. C. W. A., Inter)*

22. It is often suggested that the proper control of inventory can make a substantial contribution to the efficiency of a business. Discuss this and suggest control measures which might be applied. *(I. C. M. A., Part IV)*
23. Five hundred tons of cement were purchased, received in stores and later issued to several contracts. State, in chronological order, the records involved in this transaction giving specimens of forms used. *(I. C. W. A., Inter)*
24. Take an industry with which you are familiar and state clearly what steps you would take to ensure the closing of raw material and stores accounts for a month sufficiently early so that the necessary analysis for monthly accounts will be ready by the fourth working day of the subsequent month.
Your answer should discuss both the financial and cost aspects of receipts, issues and stock. *(I. C. W. A., Final)*
25. Describe the procedure to be followed for purchase of store till the payment of the bill. How would you ensure through the procedure against double payment of a bill? *(I. C. W. A., Inter)*
26. Between the initiation of purchase and issue of stores to different shops, enumerate the important documents you will like to introduce for an effective control of material cost. *(I. C. W. A., Inter)*
27. In addition to purchase prices of stores, other expenses are incurred until they are used in the factory. How would you deal with them in cost accounts?
• *(I. C. W. A., Inter)*
28. A cement company contracts with a Jute Mill to supply 10,000 gunny bags each month regularly for two years. The price to be paid will be actual cost of each month subject to a minimum price. In order to get prompt payments, the Jute Mill is allowed an initial payment based on the minimum price. The final invoice is received after about two months of initial payment. As the Accountant of the Cement factory, suggest a procedure for keeping a control on the payments made to the Jute Mill. *(I. C. W. A., Inter)*
29. Describe briefly the documents used in an organisation from the time a material is received in a factory till it is issued for consumption. *(I. C. W. A., Inter)*
30. As part of a cost audit, you are making a test check of the routine followed from the raising of a purchase requisition by the stores department to the entries covering the receipt of the goods in the stores and cost ledgers. Enumerate the documents and entries you would inspect, giving brief details of the main points you would check. *(I. C. W. A., Inter)*
31. You observe as a Cost Accountant of Modern Tools Ltd. that there is no systematic procedure for the payment of Supplier's Invoices with the result that many times payment is made in respect of (a) defective materials (b) materials lost in transit (c) materials returned to suppliers, etc.
Draft a suitable note for the information of the Managing Director explaining the proper procedure to be followed for the receipt of materials and payment for the materials received, along with the specimen forms to be used. *(I. C. W. A., Inter)*
32. A manufacturer with works in London creates a new factory in a provincial town and in order to expedite production, transfers certain raw materials from the London factory storehouse and diverts others (for which contracts had been made for delivery to the London works) at extra delivery cost to the new factory. In the former category are copper and spelter to be used in the foundry, as well as certain consumable stores. In the latter category is coal. How would you propose to deal in your costs with the additional expenditure incurred for production from the provincial factory? Give reason for your proposals. *(I. C. M. A., Inter)*
33. Sometimes due to non-availability of railway wagons, materials are brought in by road transport costing five times the railways freight. Sometimes, due to immediate

requirements, materials are obtained by air freight the cost of which exceeds even the cost of material. Discuss the merits and demerits of following alternative procedures of charging the extra cost :

- (a) charging only to specific orders using these materials ;
- (b) absorbing the transport cost equitably in all production ;
- (c) not taking the extra transport in cost accounts at all.

(I. C. W. A., Inter)

34. Devise a system for accounting of returnable containers at suppliers' and buyers' end.

(I. C. W. A., Inter)

35. How would you deal in cost accounts?

- (a) Packing boxes received free with stores but sold at a value.
- (b) Values of containers separately charged by the suppliers :
 - (i) for non-returnable containers ;
 - (ii) for which full value will be credited on return to the suppliers ;
 - (iii) for which less value will be credited on return to the suppliers.

(I. C. W. A., Inter)

36. During a stores audit, discrepancies are detected between the bin card, stores ledger and physical balances. What are the possible reasons for such discrepancies? Suggest a system by which these balances can be periodically reconciled.

(I. C. W. A., Inter)

37. What is a Goods Received Note? Give a specimen form. What purpose does it serve?

(I. C. W. A., Inter)

38. At the time of physical verification of stocks you find certain discrepancies between the quantity balances shown in the stores ledger and the physical balances. What would be the reasons for such differences? What accounting adjustments would you make?

(I. C. W. A., Inter)

39. Surplus materials of one job may either be returned to stores or transferred to another job. What procedures would you adopt? Under what circumstances can each be followed? Illustrate the forms to be used in each case.

(I. C. W. A., Inter)

40. It is a long standing practice in an industry to include an arbitrary percentage in their stores overhead to cover all losses in the stores. What are the different kinds of such losses and can you suggest any means of controlling the same?

(I. C. W. A., Inter)

41. What do you understand by maximum level, minimum level and reordering level? Calculate the above from the following data :

Reorder quantity 1500 units	Maximum consumption 400 units per week
Reorder period 4 to 6 weeks	Minimum consumption 250 units per week
	Normal consumption 300 units per week

(I. C. W. A., Inter)

42. Define the reorder level. What factors must be considered in setting this level? Does the reorder quantity have an effect on the average stock level of a component? Support your answer with a suitable explanation.

The following information is available in respect of a component :

Maximum stock level :	8,400 units
Budgeted consumption :	maximum 1,500 units per month
	minimum 800 units per month
Estimated delivery period :	maximum 4 months
	minimum 2 months

You are required to calculate :

- (i) reorder level ;
- (ii) reorder quantity.

(I. C. W. A., Inter)

43. In manufacturing its products, a company uses three raw materials, A, B and C, in respect of which the following apply :

Raw Material	Usage per unit of product (lb.)	Re-order quantity	Price per lb. (£)	Delivery Period Weeks			Reorder level (lb.)	Maximum level (lb.)
				Min.	Av.	Max.		
A	10	10,000	0.10	1	2	3	8,000	
B	4	5,000	0.30	3	4	5	4,750	
C	6	10,000	0.15	2	3	4		2,000

Weekly production varies from 175 to 225 units averaging 200.

(a) What would you expect the quantities of the following to be :

- minimum stock of A ;
- maximum stock of B ,
- reorder level of C ;
- average stock level of A ?

(b) If material B could be purchased in 10,000 lb. lots of £0.29 per lb.

- what would be the increase in the value of the average stock of B ?
- what would be the reduction in raw material costs per unit of product ?
- what would be the annual saving (assuming a 48-week production year) on material costs as percentage of the average increase in investment in stocks ?
(I. C. M. A., Inter)

44. Graph the following information relating to a period of 30 working days :

Opening stock : 100 lb

Usage : 1st 10 days : 15 lb per day.
 2nd 10 days : 12 lb per day.
 3rd 10 days : 20 lb per day.

Reorder level is 70 lb and reorder quantity is 120 lb. Any goods ordered are delivered at the end of the third day after reaching or passing the reorder level.

(a) From your graph read off :

- the maximum stock in the period ;
- the minimum stock in the period ;
- closing stock for the period.

(b) If 20 lb is the maximum usage and 15 lb is the average usage, comment on the reorder level and the minimum level.
(I. C. M. A., Inter)

45. A warehouse is following the two bin system of inventory control. The demand pattern is almost steady and is placed at 50 items per month. Purchases are made from a supplier at a cost of Rs. 120 per item and the cost of ordering and receiving supply of a replenishment order is Rs. 200 per occasion. If the stockholding cost works out of Rs. 20% of stock value, how frequently should the stock be replenished ? At a later date, if a quantity discount of 5% is offered on orders between 200 items and 999 items and 10% on orders of 1,000 or more, would you recommend accepting the discount and if so for which of the two offers ?
(I. C. W. A., Inter)

46. A furniture manufacturer needs to purchase 10,000 wardrobe mirrors for use evenly throughout the year. They are of a special design and are only available in batches of 1,000.

(a) From the details given below you are required to :

- show the annual cost based on ordering quantities between 1,000 and 10,000 at 1,000 intervals and

(ii) indicate which order size is optimum :

The price of mirrors is £5.00 each, with quantity discounts for orders of :

2,000 and 3,000 of $2\frac{1}{2}\%$
 4,000 to 6,000 of 5%
 7,000 to 9,000 of $7\frac{1}{2}\%$ and
 10,000 of 9%

The cost of each order placed of purchases is £2.00.

The cost of handling and insuring stock is £0.25 per year for each mirror received.

The value of space used for storage is £0.25 per year, based on the average stock, for each mirror.

The cost of capital is to be taken as 10% per annum based on the average stock.

Assume that each order is delivered when stock reaches zero.

(Calculations should be made to the nearest £1)

- (b) What factors would you consider have been taken into account in deriving the cost of each order placed ? (I. C. M. A., Pt. IV)

47. A Ltd. makes and sells product J2 among many others. Three raw materials are used exclusively in the manufacture of the product. You are given the following information :

Raw material	X	Y	Z
	lb	lb	lb
Standard quantity required per unit of product J2	60	40	20
Maximum stock levels	72,000	48,000	24,000
Stock on April 1	62,000	33,000	24,000
Purchase orders placed but not delivered	18,000	12,000	6,000

	Product J2 (units)
Maximum stock level	1,200
On April 1 there were :	
Stock in work in progress (material complete)	100
Stock in finished goods store	1,000
Sales orders received but not delivered	400

An order from an important customer was received on April 1 for 1,800 units of product J2. No further orders are expected to be received for this product during the quarter. In addition to completing the export customer's order, the company has decided to increase the stock of this product to the maximum level, in anticipation of orders during the next quarter.

It is also decided to increase the stock of materials X, Y and Z to maximum stock level. You are required to prepare a statement showing :

- (i) the production order requirements in respect of J2 ;
 - (ii) the standard quantity of each material X, Y and Z, needed for the production programme.
 - (iii) the purchase order requirements for materials X, Y and Z. (I. C. M. A., Inter)
48. In pricing the gallons of petrol sold, service station A follows the first-in first-out method, while service station B follows the last-in first-out method. On 1st January both had the same quantity in stock viz. 6,000 gallons @Rs. 2.60 per gallon. During the month each station received additional supplies of 6,000 gallons @Rs. 2.75 per gallon. Sales for each of these two stations during the month were 8,000 gallons @Rs. 2.90 per gallon. Determine for each service station the profit earned during the month and the value of petrol in stock at the close of the month (I. C. W. A., Inter)
49. From the data below answer the following :
- (a) What is the simple average price of the four weeks' receipt of material A ?
 - (b) What is the weighted average price of the four weeks' receipt of material B ?
 - (c) What is the value of the balance of material A in stores at the close of the fourth week if issued on FIFO basis ?

- (d) What is the value of the fourth week's issues of material B if they are priced on LIFO basis ?

Stores documents .

	<i>Raw materials received</i>				<i>Issued to works</i>	
	A		B		A	B
Weeks	lbs.	£	lbs.	£	lbs.	lbs.
1	500	1200	1250	1690	350	1500
2	600	1260	1400	1690	500	1200
3	400	880	750	1050	600	1300
4	500	960	1600	2400	600	1100

Opening balance A— 400 lb , value £720 ; B—2000 lbs , value £2900

(I. C. M. A , Pt. II)

50. The stock of material A as at 1 4 63 is 500 units at Re. 1 per unit. Following purchases and issues of this item were made subsequently

<i>Purchases</i>				<i>Issues</i>	
Date	Units	Rate	Date	Units	
1963		Rs	1963		
April 6	100	1.10	April 9	500	
" 20	700	1.20	" 22	500	
" 27	400	1.30	" 30	500	
May 13	1000	1.40	May 15	500	
" 20	500	1.50	" 22	500	
June 17	400	1.60	June 18	500	
" 28	600	1.70	" 29	500	

Prepare a statement, showing how the value of the above issues should be arrived at under the LIFO and FIFO methods.

(I. C. W. A , Inter)

51. The following transactions took place in respect of a material item :

<i>Date</i>	<i>Receipt quantity</i>	<i>Rate</i>	<i>Issue quantity</i>
2 3 64	200	Rs. 2.00	
10 3.64	300	Rs. 2.40	
15 3 64			250
18.3 64	250	Rs. 2.60	
20.3 64			200

Prepare a period ledger sheet pricing the issues at (a) simple average rate and (b) weighted average rate.

(I. C. W. A., Inter)

52. (a) Copper is one of the important raw materials stored by ABC cable company. There are wide and sudden fluctuations in copper prices from time to time. From the following transactions for the month of May 1973, prepare the Stores Ledger account for copper for this company adopting a suitable method of pricing for the issues. Issue rates may be rounded off to nearest rupee for convenience.

May 1	Opening balance 3,000 Kgs. @ Rs. 15 per Kg.
" 3	Purchased 5,000 Kgs. @ 16.00 per Kg. (RR No. 101).
" 4	Issued (MR No. 101) 1,200 Kgs.
" 10	Surplus from production returned to stores (SC No. 301) 200 Kgs.
" 15	Stock verified (SV Note No. 401) and quantity 7,050 Kgs. was found.
" 20	Issued (MR No. 102) 4,000 Kgs.
" 25	Purchased (RR No. 102) 4,950 Kgs @ Rs. 13 per Kg
" 30	Issued (MR No. 203) 3,000 Kgs.

- (b) Explain the method of pricing followed in part (a) above and indicate why this method is preferred over other methods.

(I. C. W. A., Inter)

53. The Fairdeal Granary was not maintaining a perpetual inventory system till recently. Only physical inventory was taken at the end of each month. The physical inventory

at the end of December, '74 showed 200 bags of fine rice at Rs. 212.25 per bag. The following purchases were made in January, '75 ;

3rd 400 bags at Rs. 218.00 per bag.
10th 900 bags at Rs. 223.50 per bag.
15th 400 bags at Rs. 220.00 per bag.
28th 700 bags at Rs. 213.00 per bag.
30th 300 bags at Rs. 224.00 per bag.

On 31st January, '75 the physical stock was 1200 bags. You are required to calculate the value of the stock on 31st January, '75 according to : First-in first-out, Last-in first-out and average cost methods. (I. C. W. A., Inter)

54. Show the stores ledger entries as they would appear when using : (a) the weighted average method : (b) the LIFO method, of pricing issues, in connection with the following transactions :

			Value		
	Units	(Rs.)		Units	(Rs.)
April			April		
1 Balance in hand B/F	300	600	11 Issued	150	
2 Purchased	200	440	19 Issued	200	
4 Issued	150		22 Purchased	200	480
6 Purchased	200	460	27 Issued	250	

In a period of rising prices such as the above, what are the effects of each method? (I. C. W. A., Inter)

55. The Stores Ledger Accounts of a manufacturing Company reveal the following entries of a particular material.

Date	RECEIPT			ISSUE		
	Quantity in units	Rate Rs.	Amount Rs.	Quantity in units	Issue price	Amount Rs.
1981						
January						
2	4,000	1.80	7,200			
5	2,000	1.75	3,500			
18				10,000		19,500
February						
3				5,000		9,750
14	3,000	1.85	5,550			
18	3,000	1.90	5,700			
20				10,000		19,200

Opening stock as on 1.1.81 was 20,000 units valued at Rs. 40,000. Closing stock as per physical verification on 28.2.1981 was 6,950 units.

Work out the method of pricing the issue which you consider to have been adopted for the issue of the material and show the working of the issue rates (correct to 2 places of decimal). Complete the account of the material and work out the value of the closing stock as on 28.2.81, on the basis of valuation adopted and also under any other method of valuation, you are familiar with. (I. W. C. A., Inter)

56. Y Limited has recently appointed a new stores controller, who has decided to introduce a new stores control system. He has asked you as a cost accountant to design for him a new material code.
- (a) You are required to prepare a report to the stores controller, in which you should briefly,
- Explain the principles to be observed in designing a materials classification code ;
 - State the advantages of such a coding system in a system of stores control.
- (b) Assume that the design of your coding system has been completed. Included in the range of Y Limited's products is a series of flat sections of varying dimensions

and in four different raw materials, aluminium, brass, copper and stainless steel. Examples of coding of two of these are

Material	Dimensions			Code Number
	Length	Thickness	Width	
Stainless Steel	4'	$\frac{1}{2}$ "	$3\frac{1}{2}$ '	04081415
Brass	$8\frac{1}{2}$ '	$1\frac{1}{2}$ "	2"	02172208

(i) Determine the code for the following

Aluminium $6'6" \times \frac{1}{4}" \times 3\frac{1}{2}"$

Copper $1' \times 1\frac{1}{2}" \times 4\frac{1}{2}"$

(ii) Describe the type of bar as defined by these codes

03112902, 01071721

(I C M A, Pt IV)

57. A foundry is melting pig iron producing castings. Coke and limestone are used to melt the metal, 150 Kgs of coke and 50 Kgs of limestone are required to melt one tonne of pig iron. The loss in melting is 5%, and the rejections amount to 10% of the castings made. Cost of pig iron is Rs 895 per tonne. Cost of coke is Rs 650 per tonne. Cost of limestone is Rs 100 per tonne. Rejections fetch a return of 60 paise per Kg. Find the cost of raw material per Kg of saleable castings.

(I C W A, Inter)

58. The annual accounts of a trading company are to be made up to December 31 but it was not possible to carry out a stock-taking until January 5 at which date the stock was valued at cost at £68 567

The following transactions took place between January 1 and 5

Goods received	£ 4,600
Goods returned	200
Sales	10,500
Return by customer	625

The rate of gross profit is 25% of cost

Prepare a statement to show the valuation of stock as at December 31

(I C M A, Pt II)

59. From the following particulars work out the issue rate per 1,000 each of first class and second class bricks

- Paid for supply at the kiln site for 30 lakhs first class bricks @ Rs 30/- per 1,000
- Paid for supply at the kiln site for 60 lakhs second class bricks @ Rs 25/- per 1,000
- Paid carriage charges for carrying all bricks from kiln to store yard @ Rs 1 50 per 1,000 bricks
- Paid unloading charges Rs 90/- (lump sum)
- Paid for stacking in the store yard Rs 180/- (lump sum)
- Breakage in handling 1% for first class bricks, 2% for second class bricks.

(I C W A, Inter)

CHAPTER 3

LABOUR COSTS

Labour is another important factor of production. Labour cost consists of the hourly, daily or weekly wages or the monthly wages or salaries paid to an employee. The accounting and control of labour cost is a major problem for the management in dealing with which the cost accountant has an important role to play. To this end, the cost accountant can, besides compiling wages costs, prove himself useful by presenting information on matters such as costs of recruitment and training, labour turnover, idle time, overtime and shift work, labour efficiency, wastage and spoilage due to labour faults, and various other analyses relating to labour. Control of labour costs is another important functional area where the cost accountant makes very useful contribution. Effective labour cost control may be exercised through (i) proper production planning, (ii) development of labour time and wage standards and labour budgets, (iii) performance reports of labour, and (iv) installation of suitable wage structure and incentive payment, and one of the tasks of the cost accountant is to co-ordinate these activities and properly advise the management to achieve control.

Utility of Labour Cost Data. Accumulation and analysis of current labour costs and trends are necessary for planning, control and decision making. Need for labour cost data would arise for the following purposes :—

- (i) Short-term reduction and long-term minimisation of labour costs (e.g., through study of the learning curve).
- (ii) Make or buy and equipment replacement decisions.
- (iii) Negotiations with labour unions over grievances and disputes.
- (iv) Pricing and formulation of marketing strategies.
- (v) Maintenance of suitable compensation level (wages structure) for workers.
- (vi) Upholding worker productivity.
- (vii) Maintaining planned volume of production.

Recruitment of Workers. In most concerns there would be a separate department known by different names, such as Personnel or Employment Department, or Labour Bureau that would be responsible for all work connected with the recruitment of workers. Action for appointing the workers is initiated on receipt of demands or requisitions on a prescribed form from the various departments of the concern. All appointments are made in accordance with a specified plan and labour strength is sanctioned for each department on the basis of the requirements of production. The sanction lays down the maximum number of workmen under each trade, skill and grade that may be employed in a department. The sanctioned strength should not be exceeded except when special circumstances necessitate

employment of more men. In such cases, the increased strength should first be authorised before recruiting more men. Employment of excess labour force should be guarded against as this results in increased labour cost, idle time, and redundancy leading to various complications and payment of retrenchment and other benefits if workers have to be retrenched.

Recruitment may be made in several ways ; as for example, from out of a waiting list of applicants, by calling men by advertisement, or through Employment Exchanges. Selection is normally made after interviewing the applicants and if necessary, after trade tests with which a representative of the department concerned is usually associated. The general practice is to throw open the vacancy in higher posts to the existing workers employed in lower posts and if one happens to be selected, only the lower post needs to be filled by an outside candidate.

SERVICE HISTORY CARD				
Name	Permanent address	Identification Mark		
Clock No.....	Present address	Grade (on appointment).....		
Date of birth.....	Trade (on appointment).....	Place of birth.....		
Insurance Card No.....	Rate of pay.....	Date of entry in service.....		
Education and Qualification.....	Provident Fund Account No.....	Date of permanent appointment		
Date of retirement....	Previous experience reference	Reasons for discharge...		
Specimen signature	Date of discharge.....			
Changes in Pay and Service				
Date	Trade	Grade	Rate of pay	Reason for change (Increment, transfer, promotion, demotion, or other disciplinary action)
Leave Record				
Date	Entitlement	Leave taken	Reason	

Fig. 3.1. Service History Card

On employment, a new worker is assigned to the department for work and the Wage Office is informed simultaneously so that he may be placed on rolls for the booking of his attendance and his Service History Card or Employees' Personal

Record (Fig. 3.1) opened. Maintained for each worker to record his service particulars, this card gives the personal details of the workers and is a sort of a history sheet meant to record all essential information about him during his employment with the organisation.

Each worker is allotted a number known as ticket number, token number, clock number, or check number. There may be one running series of ticket numbers for the factory as a whole, or separate series for each department may be maintained. In the latter case, the ticket number of a man should be changed when he is transferred from one department to another. The ticket number is quoted on all payment and accounting documents wherever the name of the worker appears. Ticket number is required for the following purposes :—

- (i) *Identification* : More than one worker may have the same name in which case allotment of separate ticket numbers for each of them makes identification easy.
- (ii) *Recording of attendance* : As we shall study later, ticket numbers are required in the token or disc system of attendance for workers. In the clock system of recording attendance, the workers' clock cards can be conveniently arranged in the card racks in the serial order of the clock numbers of the workers.
- (iii) *Simplification of work* : In many of the documents, it would suffice to mention only the ticket number of a worker instead of writing his name in full.
- (iv) *In mechanised systems of accounting* : Ticket numbers are essential when accounting is done on machines. The names of the workers and all other information about them are usually required to be transcribed from words to figures before they are fed into accounting machines.

Discharge of Workers. In order to maintain good labour relations, discharge of workers where necessary, should be made within the framework of a set of rules and procedures mutually agreed upon by the employer and the employees. Before a worker is discharged for inefficiency, misconduct, or such other reasons, he should be given full opportunity to explain his case. Lay off or retrenchment of workers due to lack or shortage of work can be made only under certain conditions, usually laid down by Acts, Tribunal awards, etc. As retrenchment involves payment of retrenchment benefits and loss of trained worker it is rather expensive from the point of view of the employers.

Casual Workers (Badli or Substitute Workers). In some organisations, workers are often appointed on a purely temporary basis for short periods. The following procedure should be followed in dealing with such appointments :—

- (i) All records regarding appointments and discharge should be maintained as usual.
- (ii) Prior approval of the competent executive should be obtained for recruiting such workers.

- (iii) Copies of appointment letters or intimations of appointments should be given to the Timekeeping Department for recording attendance and to the Wages Department for calculation of wages and disbursement under the normal procedure.
- (iv) As in the case of regular workers, job time should be reconciled with attendance time or linked with the work done.
- (v) At the time of termination of service, prior intimation should again be sent to the Timekeeping and the Wages Departments so that no overpayment is made.

Hired Labour. Sometimes workers may be hired through contractors or agents. Such workers are not taken on the rolls of the concern and all payments are made to the contractors and not to the workers. The latter are paid by the contractors only.

If the contractors' bills are paid on the basis of attendance including overtime hours put in by the workers, some records should be kept by the Timekeeping Department for checking the attendance time for which payment is claimed in the bills. Advance intimation should be given to the Timekeeping Department when hired labour is employed and the attendance of such workers should be recorded separately (separate coloured tickets may be used), distinct from the regular and casual workers employed in the concern.

Out-Workers. Workers are sometimes sent to sites or customers' premises for performing work. This happens more often in the case of building construction and erection contracts. The method of recording the attendance of such workers will largely depend upon the size and duration of work and the number of workers involved. The time records of a small number of workers deputed for a short period to the site may be kept by the foreman-in-charge, either under the handwritten method or the disc system (discussed later in this chapter). When the workers report direct at the customers' premises, the foreman should ensure correctness of the attendance bookings by carrying out checks at the spot. If the number of men engaged on site is large enough and the work is sizeable and likely to run for a long period, disc or clock system of recording may be installed.

In certain cases, work is given to the workers to be performed in their own premises with the use of their own facilities such as power, lighting, and tools. Such work would be mostly in the nature of 'contracts for fabrication' and recording of attendance and payment of wages are hardly any problem here. A proper system of control over (i) the issue and return of material, (ii) inspection of finished products, and (iii) their delivery as per schedule is all that is necessary.

Timekeeping. The opening and closing time for the factory, the lunch interval, the total working time per day and per week, and the weekly holidays are specified. While fixing the hours of normal work and overtime, the provisions of the Factories Act in this regard are kept in view. The workers are required to observe these hours ; any work beyond the normal working time ranks as overtime work.

There are two aspects of timekeeping, namely, (i) keeping attendance records for administrative and payment purposes, and (ii) maintaining job cards for costing. The second aspect, which is commonly known as *Time booking* has been dealt with in a later section of this chapter.

The responsibility for recording the attendance of workers rests on the Timekeeping office. If the size of the factory and volume of work permit, the Timekeeping office may function as a separate department; otherwise, it may form a part of the personnel department, or labour or gate office. As payment of wages to day-workers and guaranteed minimum wages to piece-workers is dependent upon attendance, an accurate and foolproof system of recording attendance is required to be maintained. Even where a worker's wages do not depend upon his attendance, as in the case of the piece-work system, booking of attendance is essential. This is because of the following :—

- (i) If a class of workers is free to attend or leave work any time at will, others who are strictly bound by the rules of attendance and punctuality are apt to be dissatisfied. This lowers the general morale.
- (ii) Although the basic earnings of the workers who are 'paid by results' are not related to the time they put in, certain other payments like overtime wages, dearness and other allowances, bonus (if bonus or premium is payable in addition to piece-work earning), leave with pay, and guaranteed minimum pay may be related to their attendance.
- (iii) If there is no check on attendance, the output of the factory is bound to fall bringing forth in its wake, all the disadvantages resulting from low production, viz. non-adherence to production schedules, bottlenecks, idle time, and increased costs.
- (iv) Payment under certain schemes of benefits for the workers like system of increments in gradual stepping up scales of pay, pension and gratuity on retirement, leave with pay, and provident fund benefits are dependent upon the continuity of service of the worker. Only complete attendance records can be a proof or otherwise of the continuity of service.
- (v) Time recording is essential if overhead recovery rates are based on labour hours.
- (vi) Statistical records of attendance may be required for research or other purposes.

Time Recording Methods. There are several methods of recording the attendance of workers. The particular method adopted in an organisation would depend upon the requirements and the policy of the management but whichever method is selected, it should be ensured that the system records attendance accurately incurring the least expenditure and is such as to minimise the risk of malpractices and fraudulent payments of wages. At the same time, the records should be correct and above board so as not to give rise to suspicion and disputes between the workers and the employers.

(i) *Hand-Written Record.* The names of the workers are entered in an attendance register provided with sufficient number of columns for recording the attendance of each worker every day. Separate registers may be maintained for

each department but if the number of workers is small, only one register may serve the needs of the entire factory. The register is filled in according to convenience, either by calling out the name of each worker as he comes in or by any other method of physical check. Workers may also sign the register themselves.

The method, though simple and inexpensive, is outdated and may be used only in very small factories. The possibility of collusion between some of the workers and the time recording staff cannot be entirely ruled out and this may lead to serious malpractices. Further, marking of late attendance, short leave, overtime, etc. involves much clerical work with chances of mistakes creeping in. For recording the attendance of out-workers, however, this may be the only practicable method.

(ii) *Check, Token or Disc Method.* In this system, each worker is allotted a metal identification disc on which his token number is suitably painted or engraved. A few minutes before the scheduled opening time, all such discs are hung up in serial order on boards placed at the factory gate. As and when a worker arrives, he takes out his disc from the board and drops it in a receptacle or hangs it in an in-board. Separate receptacles are provided for late comers. The receptacles are replaced at regular intervals; each receptacle (or late box) indicates the extent of late attendance. After the workers have come inside the factory, their attendance is recorded in an attendance record with reference to the discs placed in the in-boards or receptacles. A form of attendance record suitable for a week is illustrated in Fig. 3.2. After recording the attendance, the discs are rearranged on the boards and a similar procedure (of transferring the discs from one board to another or placing them in a receptacle) is followed for recording the departure of the workers at the closing time and also for recording the attendance of those going out and coming in during the lunch interval and on short leave and overtime working.

Another method is that instead of dropping his disc into the receptacle at the gate, the worker takes it to the department or shop where he is scheduled to work and hangs it up on another empty board. When the workers have come in, the discs not removed from the gate boards indicate the absentees. The absentees are also indicated by the missing discs on the shop boards. The recording clerk at the gate marks the attendance with reference to the boards at the gate and a similar marking is done independently by the shop clerk by physical count or with reference to the shop board wherever this is in existence. The markings in the shop need not be an elaborate one; a simple one of recording the absentees and latecomers may be sufficient. The two sets of markings, i.e. by the gate and the shop should preferably be checked and tallied by another department say, the Internal Audit or the Cost Audit Department. To some extent this method entails duplication of work but it ensures more accurate recording and the chances of dummy workers or absent workers being marked present by mistake or with mala fide intentions are lessened.

Although the check method is an improvement on the manual or handwritten records, it is not foolproof and there is the possibility of mistakes in the marking of attendance with the help of discs. Besides, the discs do not offer any proof in case of future doubts or disputes. A check is also necessary to ensure that a worker does not remove the disc of any of his absent fellow worker in addition to

[illegible]

Fig. 3.2. Weekly Attendance Record

Note : N—Normal or Ordinary working hours, O—Overtime hours

his own. The main shortcoming of the disc method, however, is that booking of attendance, other than the normal, does not follow automatically. For example, if a worker leaves early or works beyond normal working hours, separate records of short leave and overtime hours are required to be kept. This is done through short leave and overtime memos.

(iii) *Time Clock Method.* The time of arrival and departure of a worker is recorded on a card with the help of clock recorders. Several models of clock recorders manufactured by various firms are available with different contrivances but the principles or working of all the types are practically the same. Some types of clocks record time automatically as soon as the card is inserted in a slot ; in some other types a lever has to be pressed before the clock can record the time. Then again in some makes, provision exists for recording time in inks of various colours ; red ink is used to record odd time, i.e. late coming, early departure, overtime, etc. and the normal time is recorded in blue or black ink.

Every worker is allotted a Clock Card (see Fig. 3.3) which bears his individual ticket number. The cards are placed in racks alongside the clocks at the factory

CLOCK CARD								
Name :				No. :				
Trade and Grade :				Department :				
Hourly rate of Pay :				Week ending :				
Day	In	Out	In	Out	In	Out	Total hours	
							Normal	Overtime
Sun								
Mon								
Tue								
Wed								
Thu								
Fri								
Sat								
Total								
<div style="display: flex; justify-content: space-between;"> <div> Total wages..... Less deductions..... Net Pay..... Received payment as above. </div> <div style="text-align: right;"> Signed..... </div> </div>								

Fig. 3.3. Clock Card

Note : The card provides for three 'In' and 'Out' columns ; two for ordinary (normal) time and the third for clocking overtime. Some cards have only two such columns but the ruling for each day of the week provides for two horizontal columns so that morning and after-noon normal hours can be recorded in one and the same 'In' and 'Out' column.

gate or in the shops. There are usually two sets of racks on either side of a clock denoting the 'Out' and 'In' racks. At the opening time, cards are placed in the 'Out' rack, arranged in the serial order of the ticket numbers of the workers. On arrival, a worker takes out his card, punches the time by means of the clock and places the card in the 'In' rack. Thus, when all the workers present have punched their time, the cards left on the 'Out' racks indicate those who are absent. At close of work, when the worker leaves the factory, or when he goes out on short leave, he again punches the departure time and places his card back in the 'Out' rack.

The main objection to installing time recorders is the heavy initial capital outlay. But the *advantages* as mentioned below, would outweigh the expenses involved.

- (i) It is economical in operation. Firstly, the initial cost is paid back by savings in the wages of time recording staff and secondly, the same cards may be utilized for the calculation and payment of wages, and extra staff for manual recording of time and preparation of payrolls may be eliminated.
- (ii) The system is clean, safe, and quick. Being permanent and more authentic than hand-written documents, printed records avoid unnecessary disputes.
- (iii) Chances of false or fraudulent entries are reduced. Collusion between workers and the time recording staff and punching for friends by proxy can be avoided.

Mention may be made of two other types of time recorders, viz. dial recorders and key recorders. A special feature of these recorders is that they do not need individual cards for time recording.

(a) *Dial Recorders* : In these recorders, there are a number of holes around a dial. Each hole represents a number which corresponds to the ticket number of the worker. By pressing a dial arm into a hole, time is recorded automatically on a roll of paper placed inside the recorder. The record is made against the ticket number of the worker.

(b) *Key Recorders* : There are a number of keys, each key bearing the ticket number of a worker. When a key is inserted in the key hole and given a turn, the ticket number and the clock time are recorded on a sheet of paper.

An advantage of dial and key recorder is that the rolls when taken out from the recorder form a part of the payroll, thus dispensing with the necessity of copying out time records.

As the number of holes and keys is limited (to about 150), the system is slow but a major disadvantage is that the records of a worker's time of arrival and departure are widely separated on the paper roll, thus making calculation of attendance time cumbersome. The fact that a worker is not able to see for himself the time he has booked may give rise to disputes.

Attendance Time Calculation. The total attendance time of a worker for the day is calculated from the 'time in' and 'time out' recorded in the clock card. The ordinary and overtime hours are worked out separately and entered in the appropriate columns of the clock card. As overtime is usually paid at an enhanced rate, a separate entry for overtime hours facilitates calculation of overtime wages.

Most time clocks record time correct to the minute but adoption of the minute as the unit for labour accounting would involve much clerical effort. Attendance is, therefore, marked in multiples of 5, 6, 10, or 15 minutes. For instance, if the lowest unit is taken as 15 minutes, time is recorded in multiples of 15 minutes and periods of time less than 15 minutes are ignored.

Under the check system of recording time, a full day's attendance is marked in the attendance time record if the arrival and departure time of a worker is in accordance with the scheduled or prescribed time. Suitable deductions for late attendance are made by a check up of the discs in the late boxes and for the periods of short leave as obtained from short leave memos. Overtime hours shown in the overtime memos are entered in a separate column in the attendance record.

Requisites of a Good Timekeeping System. An efficient system of time-keeping should ensure the following :—

- (i) No worker should be a proxy for another under any circumstances.
- (ii) A responsible official should be present at the factory gate to ensure strict adherence to the prescribed procedure.
- (iii) As far as practicable, recording the time of arrival in the shop should be preferred.
- (iv) Piece-workers and others paid on results should also record attendance time.
- (v) Late comers should record late arrivals. Any relaxation will encourage tardiness.
- (vi) Time of departure should also be recorded.
- (vii) No one should be allowed to go out of the factory without the permission of the proper authority. Workers leaving earlier should obtain proper gate passes or pass-out slips for showing at the gate before they are allowed to record departure time.
- (viii) Time recording clocks should be correctly adjusted from time to time. Mechanical disorders should be rectified promptly to ensure that the correct time is recorded in the cards.
- (ix) The system should be smooth and quick. Unnecessary queuing at the gate should be avoided. In case of clock punching, sufficient number of clocks should be provided to avoid over-crowding.

Time Booking (Recording of Worktime). In addition to the recording of the attendance of a worker, it is also necessary to record his worktime, i.e. the time spent by him on each job or operation if he is a direct worker, or against each Standing Order Number if he is employed on indirect work. The objectives of recording worktime are as follows :—

- (a) To ascertain the particular work (job etc.) on which a worker is employed and also to find out idle time, if any, during which he is not assigned any work. This also ensures that he is fully employed during the time shown by his attendance records. For this purpose, gate time is compared with the time booked to jobs, Standing Order Numbers, and the idle time.

- (b) To ascertain the cost of work done. The worktime shown in the records when valued, indicates the labour cost of the various jobs etc.
- (c) For evaluation of wages : The amount of wages and bonus payable under several systems of wage payment is dependent upon the time taken for performing a task.
- (d) For determination of overhead rates and absorption of overhead expenses under the labour hour and machine hour methods.
- (e) For evaluation of labour performance, actual time may be compared with the budgeted or standard time.

Pre-conditions for an efficient system of time booking are as follows :—

(i) Proper instructions should be given for filling the time sheets correctly. The implications of the system should be made known to all those who are involved with the work.

(ii) Idle time should not ordinarily be charged to jobs. Separate cards are usually kept for posting and indicating the specific reasons for idle time. (See Fig. 3.18)

(iii) Proper care should be taken to ensure that time booking sheets are not lost but are suitably retained after completion.

Various types of forms are in use for recording worktime. The details contained in a form would vary according to the purpose it is to serve and in accordance with the requirements of the business. It is, therefore, not possible to standardise the design of worktime records. A few representative types are described below :

(a) *Daily Time Sheets* : One sheet is allotted to each worker and the time spent by him on each job during the day is recorded. (See Fig. 3.4.) This is suitable for small jobs of short duration. An advantage of this method over the weekly time sheets described below is that because timings are to be recorded very frequently, the tendency to accumulate work and write down the timings later from memory is curbed. This ensures relatively more accurate booking.

Daily time sheet is seldom used as it needs a lot of paper work. It may be useful in a factory where jobs given to the workers are frequently changed in course of the day, e.g. in the case of maintenance workers who work on different jobs in different departments.

(b) *Weekly Time Sheets* : Here also one sheet is allotted to each worker but instead of recording the work done for a day only, record of time for all jobs during the week is made (See Fig. 3.5). Unless promptly recorded, the timings in the weekly time sheets, however, tend to be inaccurate.

Weekly time sheets are commonly used for recording time for jobs which continue for long periods, e.g. building or construction work. Compared to daily time sheets, weekly time sheets need less paper work and the clerical cost is reduced.

The subject of idle time has been dealt with later in this chapter. Idle time when it arises, is analysed according to its causes and is booked in the time sheets to the appropriate indirect work order or Standing Order Number allotted for the purpose. In some cases, a column is provided in the time sheet to record idle time. Alternatively, idle time may be recorded separately in an idle time card, a specimen of which is given in Fig. 3.18.

DAILY TIME SHEET									
Name Clock or Ticket No. Trade and Grade				No. Date Department					
Work Order No.		Particulars	Time		Total Hours		Cost		
Direct or Job	Indirect or Standing Order No.		Start	Finish	Ordinary	Overtime	Ordinary	Overtime (normal)	Overtime (premium)
Total hours							Signed		Worker
Total cost .							Signed		Foreman
Attendance time									

Fig 14 Daily Time Sheet

[illegible]

Fig. 3.5. Weekly Time Sheet

(c) *Job Tickets* : Job Tickets (Job Cards or Job Time Reports) are made out for each job (job would mean an operation also) and are allotted to each worker. (See Fig. 3.6). When a man takes up a job, a job ticket bearing the particular job number is given to him, the time of taking up the job and the time of finishing it are entered in the ticket. As soon as a job is completed or suspended for some reason, the worker is given a card bearing the number of the next job which he is

JOB TICKET/JOB CARD			
Job or Work Order No Name of worker Clock or Ticket No Hourly rate of pay	No Date Department.		
Description of Job (or Operation)	QUANTITY		
	Produced	Accepted	Rejected
Time start Time finish Hours taken Standard hours Bonus hours* Total cost Signed...			
*Included in the cost of the job and not charged to overhead			

Fig 3 6 Job Ticket or Job Card

required to take up. Thus, besides recording time and cost for a job, the job ticket serves the purpose of an authority and a guide sheet instructing the worker to take up particular jobs. The job ticket, however, does not provide ready means for the reconciliation of attendance time with job time, and a separate analysis according to each man is necessary for the purpose.

(d) *Labour Cost Card* : This card is meant to record the time taken on the various operations of the job by all the workers employed on it. The Labour Cost Card (Fig. 3.7) details all the operations for a job and constitutes the authority for carrying out the various operations. Instead of allotting one card to each worker, the same card is passed round and the time taken by each worker on that job, for different operations, is recorded on it. When priced, this card gives the total labour cost of the job. Any excessive time or labour cost for a job can be easily seen from the card—this assists in cost control. Sometimes, columns are provided for recording details of materials so that complete cost of the job can be

LABOUR COST CARD										
Job or Work Order No..... Specifications.....				No..... Date.....						
Operation	Department	Date	Worker's Ticket No.	Specified or Standard Time	Actual Time			Rate	Amount	
					Start	Finish	Time taken			
Details of material					Checked by				Total Cost	

Fig. 3.7. Labour Cost Card or Circulating Job Card

Note : Where bonus is payable, suitable columns may be introduced for booking bonus hours and bonus amount.

ascertained from the card. It is for this reason that labour cost card is also often known as Job Card.

A disadvantage of labour cost card is that if a job runs for a long period, reconciliation of time booked with attendance time becomes difficult.

(c) *Piece-work Cards* : Individual time taken for jobs on piece-work is not usually recorded. Booking of piece-work time is, however, useful for determining the higher slab rates for piece-work if payment is made under the differential piece-work system.

A piece-work card is allotted to each piece-worker or to each group of workers if group system of piece-work is in vogue. The cards may be made out separately for each job or alternatively, one card may serve the purpose of recording the work done on several jobs ; the number of pieces against each job and the time spent on them are recorded. A typical form for a piece-work card is given in Fig. 3.8.

(f) *Combined Time and Job Card* : The particular feature of this card is that it records both the attendance time and the work time of a worker on one sheet (Fig. 3.9). Reconciliation of gate time with work time is thus simplified and any discrepancy between the two can easily be brought to light. The combined card can be more conveniently used when the recording of time is done by means of clocks.

The time sheets or cards described in the preceding paragraphs may be filled in by the workers. Some concerns employ special staff who move from one shop to another and record time for all workers. The cards are filled, either manually or with the help of clock recorders. Manual records tend to be untidy and are sometimes illegible particularly when the workers are required to fill them. Further, manual recording is not accurate as there is a tendency to book only approximate time specially in the case of daily and weekly time sheets.

Recording detailed worktime may prove to be expensive in certain cases, for example where there are numerous jobs at hand and where workers are very frequently transferred from one job to another. A simple method may be to distribute the total time/wages of the workers in a department for a period to the various operations, jobs, products etc. undertaken in the department on the basis of the estimated or standard time for each, as technically determined.

Reconciliation of Attendance Time with the Time Booked to Work. At the end of the wage period or even at shorter intervals if considered necessary, reconciliation is made of the time as shown in the attendance records in respect of each worker with the effective time of his work. When a combined time and job card is in use, this reconciliation is simple as both informations would be available in the same card. In other cases, the total attendance as per the attendance card is compared with the total time booked to the various jobs on job cards, time sheets etc. If the time booked on the job cards is less than the attendance time, this indicates idle time during which the worker had done no work although he was present in the factory. Idle time is recorded in Idle Time Cards.

In process costing there is often no need to book time on job cards as the workers are mostly engaged on the same process throughout the period. No

[illegible]

Fig. 3.8. Piece-work Card

reconciliation is possible nor it is necessary, and the time as per entries in the attendance record less the time lost on account of breakdowns, stoppages, etc. is taken as the effective time to be booked to the process. In job costing also when some workers, particularly indirect workers are employed on the same work for the entire wage period, no job cards are necessary. Job cards may also be dispensed with in the case of long-run jobs such as building contracts. In such cases, a simple statement is prepared showing the names and ticket numbers of the workers employed on the same job, contract, process, etc.

TIME CUM JOB CARD									
Name.....					No.....				
Trade and Grade.....					Week ending.....				
Hourly rate of pay.....					Department.....				
Job No.	Day	Clock time		Job time		Ordinary time	Overtime	Job time	Idle time
		IN	OUT	START	FINISH				
	SUN								
	MON								
	TUE								
	WED								
	THU								
	FRI								
	SAT								
Total									
Total wages :						Signed.....			

Fig. 3.9. Combined Time and Job Card

Operations Schedule (Also known as Manufacturing Order, Labour Order, Manufacturing Progress Instruction Card or Move Order). In engineering concerns, the planning department issues advance intimation of the future workload to the foreman of the shop in the form of an Operations Schedule (see Fig. 3.10) wherein details of labour to be utilized in respect of work order or production order are shown. If the work order would pass through a number of shops which would undertake different operations, each foreman concerned should get the schedule relating to his shop. An operations schedule is comparable with bill of materials ; while a bill of materials gives a list of materials required, operations schedule contains a list of labour operations to be performed.

[illegible]

Fig. 3.10. Operations Schedule

The *advantages* of an operations schedule are as follows :-

- (i) The shop foreman can plan the utilization of labour and machines in advance.
- (ii) He can also plan overtime and employment or retrenchment of staff in accordance with the workload. When the machines are anticipated to remain only partly filled due to low workload, the foreman may ask for more orders.
- (iii) Operations schedule assists in the control of labour utilization. By posting job cards in a schedule, the actuals can be compared with the estimates or standards, and remedial measures may be taken if labour utilization is excessive or if rejections are on the high side. Unauthorised operations, if performed, can also be detected.

Wage Administration. Wage and salary administration is one of the important functions of the personnel management which is concerned with the

determination of how much to be paid to the employees. The major problem is to determine a satisfactory wage structure after taking into account the large number of internal as well as external factors affecting such remuneration. Some of these factors are labour legislation, collective bargaining with the labour unions, wage differential due to geographical location, cost of living and the wage level in the industry concerned.

The term wage, in a broad sense, covers all forms of cash 'compensation' paid to the employees of a business and includes salaries, bonuses, commissions and all other payments in monetary terms. By usage, the term wage has come to stand for cash compensation to the workers who are employed on non-supervisory jobs. On the other hand, the term salary refers to the compensation paid to the personnel employed on supervisory work, e.g. supervisors, executives, managers, salesmen etc.

Though primarily a concern of the management, the installation of a suitable system of wage payment in a business is of particular interest to the cost accountant. Wage systems which allow high wages have the effect of increasing labour costs but this may not always result in high total costs. High wages may have the advantage of increased production as well as high productivity, and thus, of reducing the impact of fixed overhead and wages on unit costs. On the other hand, low wages sometimes lead to high unit costs due to reduced efficiency, low morale of the workers, and increase in labour turnover. The cost accountant should assess the effect of the various systems of wage payment on costs, and help the management in adopting an efficient and economically suitable wage plan.

Requisites of a Satisfactory Wage Payment Plan. In deciding upon a satisfactory system of remuneration for labour, the following considerations are to be kept in view :—

- (i) Requirements and conditions of job or work.
- (ii) The system should be satisfactory from the point of view of both the employees and the employers. It should have the consent of the workers. This will ensure good industrial relationship.
- (iii) The wage plan should be such as to minimise or stabilise labour turnover.
- (iv) The system should provide suitable incentive to the workers.
- (v) The plan should reduce absenteeism and late attendance.
- (vi) Workers should be assured of a fair return for the efforts they put in.
- (vii) Workers should be able to produce the largest possible output of the required quality. This should result in increased productivity and lower cost of production.
- (viii) Cost of operation and administration of the system should be kept at the minimum.

Job Evaluation. After deciding upon a general wage level, the problem of the personnel management is to determine how much should be paid for a particular job, i.e. what is the worth of a job. A systematic technique to evaluate the relative worth of an individual job is job evaluation. Every job has its own

characteristics. Depending upon these characteristics, jobs demand varying degrees of the various qualifications, skill, experience, etc., on the part of the operators performing the jobs. For example, some jobs may require physical ability, others may need a high degree of mental ability, while a third category may need skill, experience, and high education. Job evaluation is the process of review, analysis, and systematic classification of a job in accordance with its characteristics, i.e. the varying factors it demands from the employees. In other words, job evaluation grades all jobs with reference to their main characteristics

JOB CHARACTERISTICS (FACTORS)					
Basic factors		Main factors			
Background skill and knowledge	—200	Education*	50		
		Training	75		
		Experience	75		
			200		
				Sub-factors	
				*Education	50
				Non-Matriculate	5
				High School	10
				Intermediate	15
				Degree & above	20
					—
					50
Skill and efforts required for job performance	200	Mental			
		Reasoning	50		
		Observation	30		
		Initiation	10		
		Physical			
		Muscular †	50		
		Stamina	50		
		Dexterity	10		
			200		
			Training	75	
					••
					••
Responsibilities	—150	Degree of supervision	50		
		Responsibility for material	50		
		Safety for others	25		
		Confidential information	25		
			150		
				Physical	
				†Muscular :	50
				High	25
				Medium	15
				Ordinary	10
					—
					50
Working conditions	—100	Hazard	30		
		Risks & Safety	40		
		Disagreeableness	30		
			100		
			Total	650	

Fig. 3.11. Job Characteristics

[Example : A job which is required to be performed by a non-matriculate but which requires high muscular strength will score, $5 + 25 = 30$ points under these two heads.]

so that the relative merit of each job in terms of work value may be determined. Each job factor is given a relative weightage and is allotted a number of points. Depending upon its nature and the extent to which it requires the various factors for its performance, a job scores a number of points. A job requiring a large number of these factors will rank high in the process of job evaluation compared to another which has smaller number of these factors. Again, two dissimilar jobs may have the same gradation if each of them has the same number of points. It should be noted that job evaluation is concerned with the characteristics of jobs only and it has nothing to do with the rating of the employees performing them.

The main characteristics which may be taken into account for the purpose of job evaluation are given in Fig. 3 11. The list is only illustrative and is by no means exhaustive. The points shown against each characteristic are hypothetical. Each concern will have its own method of classification and valuation of the factors, depending upon the requirements of the various jobs undertaken. Nevertheless, the points once allotted for a factor become a standard against which a job is gauged and as such, these should not be subjected to frequent changes.

The next step in the process of job evaluation is to review the specifications of a job and analyse it into its various characteristics and finally, evaluate each job in terms of points, as illustrated below :

JOB FACTORS						
Job No.	Particulars of job	Back-ground skill and knowledge	Skill and efforts required for job performance	Responsibility	Working conditions	Total points evaluation
A	..	20	40	50	40	150
B	..	60	10	35	70	175
C	..	25	80	100	10	215
D	..	150	20	30	50	250
E	..	200	100	5	90	395

The jobs are ranked in the order of points obtained and are placed in a number of arbitrary grades. Wage scales or ranges of pay are fixed for each of these grades. This would mostly be a matter of negotiation with the trade unions. The wages fixed will also depend upon the general pay structure established in the industry or any wage awards given and will be related to the cost of living in the locality. The gradation and fixation of wages for the various groups are illustrated below :

Points Value	Grade	Pay Scale fixed (per month)	Points Value	Grade	Pay Scale fixed (per month)
50-99	I	Rs. 300-5-350	300-449	V	Rs. 600-15-690
100-199	II	Rs. 350-5-400	450-549	VI	Rs. 700-20-800
200-249	III	Rs. 400-10-500	550-599	VII	Rs. 800-20-1,000
250-299	IV	Rs. 500-10-600	600-650	VIII	Rs. 1,000-30-1,200

A job which needs high education, training and experience but involves little supervision and less hazards may have, say, a total of 220 points allocated to it. The pay scale for such a job may, therefore, be fixed at Rs. 400-10-500 (Grade III).

While fixing the wage structure, it should be seen that the change of wage scale from one grade to another is commensurate with the increase in the job value and that, within the grade itself, the scale is progressive enough to cater for the seniority and increasing experience of the men.

There are two non-quantitative methods of job evaluation which do not utilize the factors or points values. In one method known as the grading method, a number of grades are fixed and arranged in the order of their importance, e.g. unskilled, semi-skilled, highly skilled, supervisory, and administrative. Jobs are reviewed and then placed in one or the other of the grades according to requirements. Pay scales are fixed for each grade in the manner discussed above.

The other non-quantitative method of job evaluation is known as the Ranking method. Jobs are graded from the lowest to the highest : each job is valued in terms of the other jobs and a wage rate is fixed for it depending upon the wage structure prevailing in the locality.

The Grading and Ranking methods, though simple to use, easy to comprehend and the least costly of all the job evaluation methods are less accurate than the factors and points methods which have a quantitative approach.

The uses to which job evaluation method may be put to and the *advantages* accruing from it are detailed below :

- (i) The main utility of job evaluation, which has already been discussed, is for the fixation of wage structure. Fixation of wages on an impersonal basis, depending only upon the requirements of the jobs, cuts out personal errors and biases. This is fair both for the employer and the worker.
- (ii) Anomalies in the current wages of individual employees are revealed by plotting a scatter diagram showing the actual wages vis-a-vis the job rating points.
- (iii) Useful information is available for appointing new workers. As the exact requirement for each job is known, it becomes a simple matter for the personnel department to select the most suitable men out of a number of candidates applying for a post. Similarly, changes from one grade to another on transfers, promotions, etc. can be made on a rational basis.
- (iv) Job evaluation improves labour relations as it rules out unfairness, nepotism, etc.
- (v) It points out to the particular needs of a job. For example, it can be ascertained whether a job requires more safety precautions, more supervision work, or more training for the operator who is asked to perform it.

Merit Rating. The system followed in many concerns for wage progression (through promotion, advancement etc.) is based on the determination of the relative merits of the employee. One systematic method of determining the relative worth of the employee is known as Merit Rating.

Merit rating is the comparative appraisal of the individual merits of an employee. While job evaluation is the process of analysis and classification of jobs according to their characteristics, merit rating refers to the evaluation of the merits of persons and their classification into groups on that basis. The method of merit rating lies, broadly, in keeping an individual's records of performances and assessing these performances through some norms or standards. The intention is to suitably reward an employee on the basis of his merit. Merit rating provides a system of incentive without applying the detailed procedure of work study and is particularly useful for remunerating, on relative merits, indirect workers whose performance is difficult to measure.

Certain factors or qualities are established for the purpose of rating. Examples of factors in common use are given below :

- (i) Quality of work done
- (ii) Quantity of work done
- (iii) Sense of responsibility
- (iv) Initiative
- (v) Reliability and integrity
- (vi) Knowledge, skill, experience, and aptitude for work
- (vii) Co-operation and discipline
- (viii) Sense of judgement
- (ix) Attendance and punctuality

Each of the factors is assigned a point value or point rating and each employee is rated according to the extent of the point value he possesses. The employees may be ranked either individually in order of the points they score, or they may be arranged in groups according to their common ratings. The rating of an individual or a group may also be expressed as a ratio of the normal or standard rating.

The objectives of merit rating are summarised below :

- (i) To find out the suitability of a worker for a particular job. For this purpose, merit rating is linked with job evaluation.
- (ii) To assess an individual's merit for promotion, grant of increment, payment of reward for good work, etc.
- (iii) To serve as a basis for incentive payment and for simplification of wage-structure.
- (iv) To analyse the workers' defects and to bring out their strong points and special abilities.

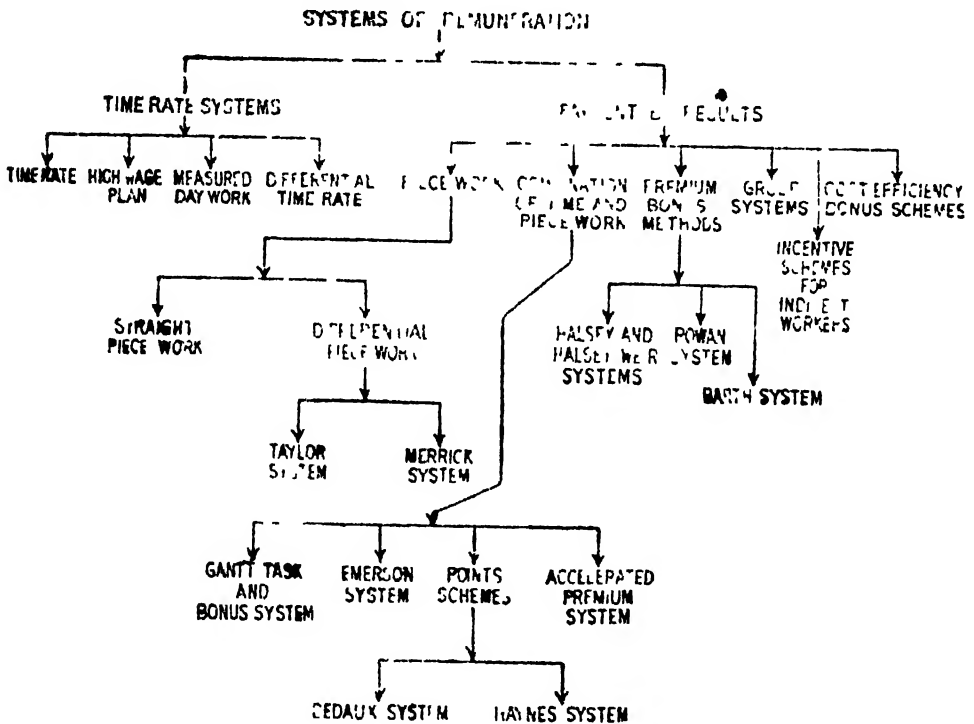
Merit rating improves labour relations, reduces labour turnover, and stimulates competition among the employees ; all resulting in increased production. It has, however, the under-mentioned shortcomings and limitations :—

- (i) Being a matter mostly of opinion, the rating often tends to be erroneous. This may lead to employee unrest.
- (ii) The incentive offered on the basis of merit rating is not strong enough.

- (iii) Irrelevant factors may be given prominence. For example, raters (persons responsible for rating the employees) may be highly influenced by only one specific (but strong) good or adverse factor which they notice in an individual.
- (iv) Raters may be influenced by past rating records of an employee. This vitiates their judgement

Methods of Remunerating Labour. There are many well-known systems of remunerating labour, each of which specifies a distinct method of calculating the wages payable to workers. In practice, these basic systems have been modified and adopted in numerous ways to suit the needs of individual concerns. This accounts for the very large number of methods of wage payment in use.

Methods of labour remuneration may be broadly classified into two basic types, viz. *Time Rate System* and *Payment by Results*. These may be further subdivided into the following main types :--



To the above list, two other types, viz. indirect incentives like profit sharing and co-partnership schemes, and non-monetary incentives may be added. Though strictly not systems of remuneration, these are methods of giving incentives to workers.

Time Rate System. Known by various other names such as time work, day work, day wages, and day rate, the Time Rate system is perhaps the oldest system of remunerating labour. In this system, the worker is paid on his attendance at a specified rate of pay regardless of his outturn. The wage rate for a day worker

which may be fixed on hourly, daily, weekly, fortnightly, or monthly basis depends upon the nature of his trade and skill The rate is fixed taking into account the rates prevalent in the particular industrial locality for similar trade and skill. The rate may either be a fixed one, or there may be a progressive scale of pay starting from a minimum and rising up to a maximum, in stages, through periodical increments

The method of calculating wages under the time rate method is illustrated below :

EXAMPLE 3 I

Calculate the normal and overtime wages payable to a workman from the following data -

Days	Hours worked	Rates	
Monday	8 hours	Normal working hours	8 hours per day
		Normal rate	Rs. 2 00 per hour
Tuesday	10 "	Overtime rate	Hours up to 9 in a day at single rate and hours beyond 9 in a day at double rate or up to 48 hours in a week at single rate and hours beyond 48 at double rate, whichever is more beneficial to the workman
Wednesday	9 "		
Thursday	11 "		
Friday	9 "		
Saturday	4 "		
	51 hours		

(I C W A, Inter)

ANSWER

Day	Normal working hours	Total	Hours worked		
			At Normal rate	Overtime	
				Single rate	Double rate
Monday	8	8	8	—	—
Tuesday	8	10	8	1	1
Wednesday	8	9	8	1	—
Thursday	8	11	8	1	2
Friday	8	9	8	1	—
Saturday	8	4	4	—	—
	48	51	44	4	3

Normal wages on time rate = 44 hours × Rs 2 00 Rs 88

Overtime wages Single rate = 4 hours × Rs 2 00 = Rs 8

Double rate = 3 hours × Rs. 4 = Rs. 12

Total Wages Rs. 108

Note : On weekly basis also, the overtime for three hours (i.e., 51 hours minus 48 hour) is payable at double the rate.

Time work is most suitable for the two extreme grades of workers, viz. the highly skilled and the unskilled (including learners and apprentices) and for certain types of work, such as

- (i) Where output of the worker is beyond his control, e.g. where his speed of work is restricted by the speed of the machines or conveyor belts, or where his work is interlinked with and is dependent upon the work done by other workers
- (ii) Where output cannot be measured nor can any standard time be fixed for it, e.g. maintenance and repair work
- (iii) Where close supervision of work is possible
- (iv) Where quality, accuracy and high precision in work is of primary importance. As the time-worker has no necessity for nor a tendency to speed up work, this results in less spoilage
- (v) Where increase in production or productivity is not commensurate with the incentive paid

The advantages of the time rate system are as follows —

- (a) Calculation of wages is simple involving less clerical expenditure
- (b) The worker easily understands the calculation
- (c) He is assured of a steady income for each wage period

Although time rate of payment is widely applied, the disadvantages and shortcomings attached to the system far outweigh its merits. These are summarised below

- (i) From the workers' point of view, the system does not encourage initiative. As the same rate and amount of wages are paid to the fast and the slow workers, there is no incentive for increased efficiency and output.
- (ii) Decrease in productivity leads to rising labour cost and reduction in profit.
- (iii) Decrease in production results in upsetting of production schedules, creation of bottlenecks in production, and increase in the cost per unit.
- (iv) Estimates of labour cost and quotations given to customers, if based on time work, may ultimately prove to be wrong as the actual performance will depend upon the inefficiency or efficiency of the time worker. The employer is entirely dependent on the workers in regard to the quantum and rate of production.
- (v) Standards for labour are difficult to set.

There are a few variations of the time rate system in use which make an attempt to introduce an incentive element in the time wages. As payments are still based on attendance and are, strictly speaking, not related to output, these methods cannot be classed under any system of payment by results. Three such methods are discussed below.

- (a) High Wage Plan: Under this system, the time rate of a worker is

fixed at a level higher than the usual rate prevalent in the locality for that industry. Correspondingly, a high standard of efficiency and output is required from him. Suitable working conditions are created to enable the worker to achieve the standard. Those who are not able to come up to the standard are taken off the scheme.

The High Wage Plan is suitable where high quality of work and also increased productivity are required. For the successful implementation of the plan, it should be possible to measure output in suitable units and to set standards for them. The method has the following *advantages* :—

- (i) Like the ordinary time rate method, it is simple and inexpensive to operate.
- (ii) It provides suitable incentive, lucrative enough to attract highly skilled and efficient workers.
- (iii) The method aims at the reduction of unit fixed overhead cost resulting from increase in production.
- (iv) Increased productivity may result in reduction of unit labour cost.
- (v) Less supervision is required.

(b) Measured Day Work (or Graduated Time Rate) : This method is based on the principle that the hourly rate of the time worker consists of two parts ; one of the parts is the fixed element based on the nature of the job, i.e. the rate for this part is fixed on the basis of job requirements, and the other part is the variable portion which varies for each worker depending upon his merit rating and the cost of living index. The aggregate of the two parts, termed as Measured Day Work, constitutes the composite day rate of a worker.

The complications involved in this method restrict its suitability as a system of remuneration. As the rate is based on two different elements, there are separate time rates not only for each worker but also for each job. The problem is further complicated if the workers move frequently from one job to another since in that case there would be, by permutation, a very large number of rates in use. The rates so fixed are not easily understood by the workers. Further, merit rating tends to be arbitrary and unless changed at rapid intervals, the rating will not reflect the correct ranking of the qualities of a worker. Due to these reasons, the measured day work system does not find much favour with the workers as well.

(c) Differential Time-Rate : Different hourly rates are fixed for different levels of efficiency. Up to a certain percentage of efficiency, the normal time or day rate is paid. The rate gradually increases in steps for efficiency slabs beyond the standard. Being linked with the output and efficiency of the workers, this system cannot strictly be classed as a time rate method of payment. This is more akin to the differential piece-work system dealt with later. The method is illustrated below, with the help of assumed figures :

Up to Standard (say, 75 % efficiency)		Day Rate
From	75 % to 80 % efficiency	Normal (Rs. N per hour)
"	81 % to 90 % "	1.10 × N
"	91 % to 100 % "	1.20 × N
"	101 % to 120 % "	1.30 × N
"		1.40 × N

Payment by Results. Systems of remunerating labour in which the payments made have direct relation with the outturn of the workers are known as systems of 'Payment by results'. For many such systems, the attendance of the worker or the time he takes for doing a job has no bearing on the rate or amount of payment. A special feature of these systems is that the worker gets a direct financial incentive and he is at liberty to increase his outturn and thus receive payment according to his ability, energy, and speed of work. Systems of payment by results may be broadly grouped into four categories, namely :

- (a) Systems in which the payment is directly proportionate to the worker's output, e.g. straight piece-work system ;
- (b) Systems in which the proportion of the payment to the outturn increases progressively with increase in production, e.g. differential piece-work system ;
- (c) Systems in which the rate of payment decreases with increase in outturn, e.g. premium bonus methods ; and
- (d) Systems with earnings varying in proportions which differ at different levels of production, e.g. accelerated premium systems.

Requisites for a Successful Incentive System of Payment. For the successful working of an incentive system of payment by results, the following factors should be kept in view : -

- (1) The system should be simple and easily understandable by the workers. Proper understanding and co-operation keep up workers' morale.
- (2) The cost of operating the system should be reasonably low.
- (3) The scheme should be such as to be susceptible to easy supervision.
- (4) The incentive should be large enough to induce workers to achieve it.
- (5) The time lag between the performance of the work for which the payment of the incentive is due and the actual payment should be reduced to the minimum
- (6) The system should be fair enough to meet the viewpoint of the employer as well as the employees and it should be applied in a manner that would be fair to both.
- (7) The rates and standards fixed should be reasonable so that each worker gets a fair chance to earn the incentives. Unreasonably high standard of performance which the worker is not capable of achieving should not be set.
- (8) For work above the standard, the reward should be sufficiently high.
- (9) The system should be flexible so that minor changes, as necessary in the method of calculation, can be easily made in order to suit changes in production methods. Such variations should not seriously affect the basic system of payment.
- (10) The workers must be properly educated and motivated by the desire to earn money.

- (11) There should be an equitable distribution of work and no worker should suffer a deduction of earnings for factors beyond his control, such as for stoppage of work due to lack of tools, instructions, or materials, or due to power failure or due to breakdown, or slowdown of the plants. Such contingencies should be covered by,
 - (a) including extra time in the standard, wherever practicable, or
 - (b) payment of idle time wages, or
 - (c) payment of minimum guaranteed wages.
- (12) There should be a satisfactory system of inspection so that workers are paid only for good performance.
- (13) The incentive system should be conducive to the setting up of standard costs and budgetary control.
- (14) Working conditions should be as uniform as practicable so that the worker can fully control the rate of his output. Factors which normally affect output adversely are : deterioration in the quality of the input material and tools, machines of low efficiency, noise, dust, fumes, bad lighting, etc.
- (15) There should be no rate cutting and no ceiling should be placed on an individual's earning. Standards once set should not be altered unless there is a change in the method of production. Payment should be made in accordance with what has been agreed upon by the employer and the workers.
- (16) The system should be introduced on a permanent basis and should not be discontinued in times of financial stringency. No incentive system should be introduced only as a stopgap arrangement in order to temporarily tide over labour troubles.
- (17) Workers putting in the same amount of effort should get uniform incentives irrespective of the jobs involved.
- (18) Indirect workers should also be included so as to get the benefit of incentive plans.

Introduction of an Incentive Scheme. The establishment of a satisfactory system of incentive requires a high degree of managerial skill. When the incentive scheme is introduced for the first time, workers are apt to view it with suspicion, particularly so, if they had the experience of their rates being cut in the past. In order to avoid labour troubles and disputes cropping up at a later stage, it is essential that the rates and standards are correctly fixed and the system efficiently administered.

The precautions to be taken and the main considerations to be kept in view while installing a satisfactory incentive scheme are as follows :—

- (i) A start may be made either with one department, or a particular job. The department selected for introducing the scheme should be the one where relations between the labour and the management are cordial. If a job is selected for the purpose, it should be ensured that

there would be in future, no scarcity of materials and other resources required for production.

- (ii) A proper Methods Study should be conducted in order to determine improved methods of production, routing, etc.
- (iii) The scheme should be discussed with the workers' representatives. The intricacies should be explained and the workers should be assured that there would not be any rate cutting.
- (iv) Suitable instructions regarding the methods of calculation of bonus etc. and the payment of wages should be given to the time office, wage office and other departments concerned.
- (v) Suitable forms should be designed for booking of time, recording of performance, and payment of bonus and other incentives.
- (vi) In the initial stages after the introduction of an incentive system, the worker should be assisted and given all facilities to earn satisfactory incentive payment.
- (vii) As a measure of safeguard against incorrect fixation, new rates should be treated as provisional and should be finalised later only after the lapse of a specified period when the results of their actual working are forthcoming. It should be noted that this runs counter to the point at (iii) above, viz. that there should be no reduction in the rate of incentive payment. It should, therefore, be properly explained to the workers that this safeguard could at times be in their interest as well.

Work Study. Work Study is a pre-requisite for the successful implementation of all systems of incentive wage payment and is an important analytical tool used as a basis for improvement of productivity. It is a combination of two clearly distinct but closely related techniques, viz. Method Study and Work Measurement. Method Study is the process of analysis of a work to see how things are done, the objective being to improve methods. Work Measurement is the process of assessment of work with a view to eliminating inefficient time and for the purpose of setting standard for the amount of work which an employee should turn out within a given period. This involves two processes, viz. Motion Study to analyse how workers do a task and Time Study to determine how long they take to do it.

Method Study. Method Study aims at improving methods of production leading to effective use of the existing resources. Its techniques involve the following steps :—

- (i) Systematic recording of the existing layout, work allocation, working arrangement, and the detailed methods of working. This is done with the help of flow process charts and flow diagrams (for studying sequence and flow of work), motion study operation charts, and multi-activity charts (for studying methods of work).
- (ii) Analysing the process into its operation elements and examining in detail, existing and proposed methods of doing a work.

- (iii) Developing and applying new and improved methods that are easy and effective. This would indicate the best possible way of doing a work. This is done by eliminating unnecessary operations and movements, simplifying the existing operations—by changing or rearranging the operations by combining a number of operations or reducing the number of operations—and laying down the best sequence of essential operations.

Method study contributes largely to the efficiency of an undertaking. The following *advantages* of method study may be noted :—

- (a) Improved method, layout, and design of work ensures effective use of men, material, and other resources.
- (b) Unnecessary and wasteful methods are pinpointed with a view to either improving upon or eliminating them altogether. This leads to reduction in the work content of an operation, economy in human efforts, and reduction of fatigue.
- (c) Highest possible level of activity is achieved.

Work Measurement. In the process of work measurement, Motion Study precedes Time Study and the two techniques are better known as Time and Motion Study. Motion Study involves the study of the manner in which a worker performs a task so that unnecessary movements may be eliminated, easier movements may be introduced and better and effective use of the human resource can be made.

Work measurement involves establishment of the work content of an operation which has been improved and established by method study. Work content is the time required for doing a specified standard task by a worker qualified to do it. The purpose of work measurement is to determine the effective time for doing a task after separating and eliminating the ineffective or wasteful time. Another function of work measurement is to fix standard time for a task on the basis of which payment of incentives to workers may be made. The other uses are as follows :—

- (i) To provide basis for improved utilization of machine and man efforts.
- (ii) To assist in production control.
- (iii) To provide information for setting labour standards—a step towards labour cost control and cost reduction.

There are various techniques by which work measurement is carried out. These are beyond the scope of this book but mention may be made of Time Study which is the most important and well known technique for determining the work-content of a task.

The technique of time study consists of the following steps :—

- (a) Breaking or analysing the task into its constituent motions, i.e. operation or work elements.
- (b) Timing each element with the help of a stop watch or any other time recording equipment. This consists of recording the time taken by a qualified average worker to perform the operation element. Several observations are

made employing different persons to perform the task. The average of these observations gives the normal or base time required for each element. As the operators who are timed will each have different degrees of skill and efficiency, individual skill and effort of the operators are assessed during the time study ; the average normal time is obtained by multiplying each individual time with the operator's merit rating. For example, if an operator A takes, in three observations, 20, 22, and 18 minutes and another operator B takes 22, 24 and 26 minutes to perform an operation and their rating ratios are 55/60 and 50/60 respectively, the average normal time will be 19.16 minutes, as follows :—

OPERATOR A :

Minutes

$$20 \times \frac{55}{60} = 18.33$$

$$22 \times \frac{55}{60} = 20.16$$

$$18 \times \frac{55}{60} = 16.50$$

54.99

OPERATOR B :

Minutes

$$22 \times \frac{50}{60} = 18.33$$

$$24 \times \frac{50}{60} = 20.00$$

$$26 \times \frac{50}{60} = 21.66$$

59.99 114.98

Average = $114.98 \div 6 = 19.16$ minutes

(c) Allowances are made for fatigue and other contingencies like compensation for idleness inherent in the method of work, and periodic stoppages for re-grinding and re-setting of tools etc. The base time plus the time provided for the above allowances gives the standard time allowed for the operation element. Assuming an allowance of 10% for fatigue etc., the standard time for the operation, the base time for which is 19.16 minutes, will be : $19.16 + 10\%$ of $19.16 = 21.08$ minutes.

(d) The aggregate of the standard allowed time for all the elements gives the standard time allowed for a task. The work content of a task may also be expressed in terms of standard hours. A standard hour measures the amount of work which should be performed in one hour. A task for which standard time is 21.08 minutes contains $21.08/60 = 0.35$ standard hour of work and an operator who performs 100 such tasks in a week of 48 hours is credited with 100×0.35 , i.e. 35 standard hours of work.

Advantages and Disadvantages of Payment by Results. The advantages of systems of payment by results are summarised below :

- (i) Initially in the process of work measurement carried out for the purpose of fixation of standard time, all useless efforts and movements are detected and eliminated and the most economical method of doing a task is determined. This, by itself, reduces labour costs.
- (ii) Loss of production time is reduced and there is maximum utilization of the resources like space, plant and machinery.

- (iii) There is an increase in productivity ; more work is turned out in a shorter period of time.
- (iv) Increase in production results in lower costs due to the reduction in fixed cost per unit of production.
- (v) The earnings of the workers go up ; this raises personnel morale.
- (vi) It is possible to estimate labour costs and set labour standards accurately.
- (vii) Less supervision work is required.

Unless proper measures are taken, systems of payment by results often turn out to be *disadvantageous*. For example :

- (i) With the increase in the tempo of work, the quality of production is likely to deteriorate. This can, no doubt, be obviated by a strict system of inspection and quality control but at higher costs.
- (ii) If the rates are not equitable for the various grades of workers employed on similar tasks, they would cause discontent. However correct and fair the rate fixing may be, workers are not prepared to accept almost any kind of job ; they are reluctant to undertake jobs which, in their opinion, are unremunerative.
- (iii) In their eagerness to speed up in order to earn more, the workers may disregard safety precautions and thus expose themselves to greater risks of accidents.
- (iv) Most of the payment systems are expensive and need additional expenditure for installation and operation.
- (v) Group systems of payment by results, if not properly organised, result in dissatisfaction among the workers constituting the group.
- (vi) Discontentment may also be due to inefficient workers being jealous of the efficient workers who earn higher wages. Efficient workers may lose the friendship, co-operation and regard of their colleagues.
- (vii) The workers may be satisfied with a lower wage level and may not like to exert for achieving the standard expected, particularly where day rates are guaranteed. They may also be under the apprehension that if they earn high bonus, the rates may be cut.

Straight Piece-work System. This is the simplest and most common of all the methods of payment by results. In this system, each operation, job, or unit of production is termed a piece. A rate of payment, known as the piece-rate or piece-work rate, is fixed for each piece. The worker is paid on his outturn regardless of the time he takes for its performance. The earning of a worker is calculated by multiplying the number of pieces turned out by him by the specified rate for each piece.

Wages = Number of units produced × piece-rate for each piece.

The piece-work system can be applied with advantage to work of a standard or repetitive nature, where fixation of piece rate is comparatively easy and the worker is assured of an uninterrupted flow of work. Being constantly engaged on

the same type of work, the piece worker can be expected to become an expert on his job and thus, he can gradually increase his earning. The system cannot be applied where it is not possible to measure the outturn in suitable units.

Fixation of piece rate presents a major problem. The first step in rate fixation is to determine the time required to complete a piece. This can be done in several ways, viz. from past experience, or by estimation, Work Study or Time and Motion Study. If the work was previously on time rate and records of time taken to complete it are available, the average time, with suitable modification and excluding any abnormal figures, can be adopted as the basis for rate fixation. For new jobs, a few trial runs on day work basis will afford suitable estimates for fixation of the rate. Piece-work rates should not, however, be introduced before production is established. Fixation of piece rates by such methods are haphazard guesses which eventually lead to complications, losses, and labour unrest if the rates are loose or tight.

The widely used method, therefore, for fixation of piece rate is work study or time and motion study. The allowed or standard time for the job or operation is determined by time and motion study. A time study sheet shown in Fig. 3.12 illustrates the manner in which the time operation for each element is recorded and the standard time for an operation determined.

TIME STUDY SHEET	
Job : Drilling a hole, 0.05 cm. diameter, in Mild Steel Plate (Component No : 2Ac), 2.5 cm. x 3 cm. x 0.30 cm.	Department : Machine shop A Operator : Machinist Grade C Hourly rate of pay : Rs. 3.50
Operation Elements	Time observed (Average) (Minutes per piece)
Preparation	
Read/Take instructions, walk to bench and back with work, place pieces in the in-box (100 pieces in a batch)	*0.007
Operation :	
Pick up one piece, place in jig, tighten	0.060
Turn jig, place drill in position, lower drill	0.252
Drill hole	0.125
Remove drill up, clean chips, place piece in the out-box	0.156
Base time (Floor to floor time)	0.600
Fatigue and other allowance, 10%.	0.060
Standard time, per piece	0.660
*(0.70 mt. per 100 pieces = 0.007 mt. per piece)	

Fig. 3.12. Time Study Sheet

Having arrived at the standard time, the next step in the fixation of a piece rate is to correlate the time with the wage rate. This is simple if the worker has fixed assigned hourly or daily rate of pay. If the standard time per piece is assumed to be 0.66 minutes, the piece rate for the drilling operation to be performed by the Machinist Grade C (assigned rate of pay = Rs. 3.50 per hour) on 100 pieces will be :

$$\text{Rs. } 3.50 \times \frac{0.66}{60} \times 100 = \text{Rs. } 3.85$$

Sometimes a percentage is added to the standard time or to the piece rate to allow an extra incentive to the worker. For example, if it is intended to allow an extra incentive of $33\frac{1}{3}\%$, the standard time is increased to $0.66 + 33\frac{1}{3}\% \text{ of } 0.66 = 0.88 \text{ mt.}$ and in that case, the piece-rate will work out to Rs. 5.13.

Difficulty, however, arises if the worker has an assigned monthly rate of pay which increases in graded steps. As the effective hours for all the calendar months of the year are not equal, the hourly rate of pay obtained by dividing the monthly pay by the number of hours in the month varies from month to month. For the purpose of fixation of piece-work rate, an average or standard number of days for all the months is, therefore, adopted. In case of progressive pay, the average or middle point of the scale is usually adopted. This is illustrated below :

Machinist Grade B, Scale of monthly pay Rs. 600-20,1,000

Working hours per day 8

Standard working days in a month 25

Effective hours per month $= 25 \times 8 = 200$

Mid-point of scale $= \text{Rs. } (600 + 1,000)/2 = \text{Rs. } 800$

Hourly rate of pay $= \text{Rs. } 800/200 = \text{Rs. } 4$

Another method is to take the average pay as, $\text{minimum} + \frac{2}{3}(\text{maximum} - \text{minimum})$. For the pay scale given above, the average pay will be

$\text{Rs. } 600 + \frac{2}{3}(\text{Rs. } 1000 - \text{Rs. } 600) = \text{Rs. } 966.67$

The average pay is usually adopted in old factories where most of the workers have reached higher stages in the pay scales. In factories just set up, the pay adopted under the above mentioned methods will cause inflation of the piece rate.

Under the straight piece-work system, labour cost per unit remains constant at all levels of production efficiency. With the increase in production, however, fixed and semi-variable overheads are spread over larger units of production resulting in decrease in total unit costs.

Calculation of wages is simple and easy in the piece-work method. It offers a powerful incentive to workers who get wages directly proportionate to their efforts. It, however, suffers from the *disadvantages* attached to the system of payment by results stated earlier. In addition, the following further disadvantages may also be noted :—

- (i) A piece-worker gets return only to the extent of his outturn and his other special factors and qualifications are ignored.
- (ii) If a worker is satisfied with low production and consequently low wages which he considers are sufficient for him, it is difficult to maintain production targets.
- (iii) Unless there is a minimum guarantee, the worker is not assured of full pay. The wages that he earns may also vary from period to period.

A modification of the piece rate method introduces a guaranteed daily rate. Efficient workers may not need the guarantee but others may be paid at the time-rate if it is higher than their piece-work earnings. This protection may be given for only specific jobs which have relatively stiff piece rates, or it may be given for

the wage period as a whole. In the latter case, the inefficiency in some jobs may be partly set off against efficiency in the rest and the balance paid as the guaranteed wage. The difference between the guaranteed wage and the piece-work earning is generally treated as overhead cost. Guaranteed payments are, nevertheless, to be discouraged because combination of guaranteed time rate with piece-work takes away the incentive and thus makes the piece-work system less effective.

Standard Hour System of Piece-Work. The difficulties mentioned in the preceding paragraphs regarding the correlation of piece-work time with wages are obviated under the standard hour system. Also known as Piece Bonus, Time piece work, or 100 percent Bonus Plan, the standard hour system is a variant of the straight piece-work system, in which the standard time allowed for a piece is adopted as the piece rate without expressing it in terms of money. Payment is made for the standard time at the time rate if the worker completes the work within or in less than the standard time. If time taken is more than the standard, payment is still made only for the standard time allowed unless the daily rate of pay is guaranteed. The following example illustrates the method :

Hourly rate of pay	Rs. 2.00
Time allowed (Standard time)	8 hours
Case (i) Time taken	6 hours
Wages $\text{Rs. } 2.00 \times 8$	= Rs. 16.00
Case (ii) Time taken	10 hours
Wages $\text{Rs. } 2.00 \times 8$	= Rs. 16.00
But if day rate is guaranteed,	
Wages $\text{Rs. } 2.00 \times 10$	= Rs. 20.00

Compared to the ordinary piece-work system where piece rate is related to money value, the standard hour system has the following additional *advantages* :—

- It is comparatively simple to operate.
- The rate once fixed need not be changed with any variation in the basic rates of pay of the operators consequent upon change in pay structure or due to operators of different grades and rates of pay being employed on the same work.
- The method meets one of the shortcomings of the ordinary piece rate system, viz. that in the latter system, the worker does not get any reward for his loyalty and length of service and that the same piece rate applies both to the new and old workers.

Care should, however, be taken under this method to safeguard against high rated workers being deployed on work meant to be done by men of less skill on lower rates of pay.

Contract System. In this method which is similar to the piece-work system, a contractor is engaged to provide the labour force for doing a job, other facilities being provided by the concern itself and the contractor is paid an agreed amount for the service. The method enables pre-determination of the labour cost with

reasonable accuracy and is suitable where a concern does not consider worthwhile appointing labour on a permanent basis. This also relieves the management of the bother and the time involved in the matter of recruitment, administration, etc. of workers. The difficulty, however, is that there is lack of administrative control of the workers engaged by the contractor and the risk of damage and loss of equipments cannot be ruled out.

Differential Piece-work Systems. Differential piece-work systems provide for higher rewards to more efficient workers. The basic feature of all differential piece-work systems is that several piece-rates on a slab scale are fixed for a job or operation. A definite task or standard of efficiency is set for each job or operation put on piece-work. For different level-ranges of outturn below and above the standard, different piece-rates are applicable. For instance, payment at the normal piece-rate is made for work performed within and up to the standard level of efficiency. If the efficiency exceeds the standard, payment at a higher piece rate is made. For still higher efficiency, higher rates are applicable. In certain systems, payment is made at rates even lower than the normal piece-rate if the efficiency drops below a specified minimum level.

Compared to other incentive systems, differential piece-work systems offer more inducement to the workers to increase productivity and earn higher wages. These systems are, however, complicated and expensive to operate and are difficult for the workers to understand. With the increase in production efficiency, the labour cost per unit of production rises. A stage may, therefore, be reached where the advantages derived from increased production, e.g. reduced overhead cost per unit may not be sufficient to neutralise the rising labour cost.

A few well known differential piece-work systems are described here.

Taylor Differential Piece-work System. In this system, two widely differing piece-rates are set for each job. The lower rate is based on 83% of the day wage rate and is applicable if the efficiency of the worker is below 100%. The higher rate is based on 125% of the day wage rate, to which is added an incentive element of 50% of day rate. This rate is applicable to work done at efficiency levels of 100% and above.

The efficiency of a worker may be determined as a percentage, either (i) of the time allowed for a job to the actual time taken, or (ii) of the actual output to the standard output, within a specified time. For example :

- (i) Standard time allowed for a job—30 hours
Actual time of performance for the job—40 hours

$$\text{Efficiency} = \frac{30}{40} \times 100 = 75\%$$

- (ii) Standard output—10 units per hour
Actual output—12 units per hour

$$\text{Efficiency} = \frac{12}{10} \times 100 = 120\%$$

The day wages are not guaranteed in the Taylor method and because of the high disparity in the two rates, the slow worker is penalised but high rewards are attached to efficient work.

The method is illustrated below :

Wage rate Rs. 2.40 per hour

Standard - 2 units per hour or 16 units per day of 8 hours

Therefore, ordinary piece-work rate $\frac{2.40}{2}$ Rs. 1.20 per unit

Low piece rate 83% of Rs. 1.20 = Rs. 0.996 per unit

High piece rate 125% 1.20 + 5% 1.20 Rs. 2.10 per unit

If a worker, A produces 14 units in a day of 8 hours,

Efficiency $\frac{14}{16}$ 87.5%, i.e. less than 100%

Applying the lower piece rate,

Wages of A 14 Re. 0.996 Rs. 13.944 or Rs. 1.743 per hour

If another worker, B produces 18 units in a day of 8 hours,

Efficiency $\frac{18}{16}$ 112.5%, i.e. more than 100%

Applying the higher piece rate,

Wages of B 18 Re. 2.10 Rs. 37.80 or Rs. 4.725 per hour.

Merrick Differential Piece-Rate System In the Taylor system, the effect on the wages of a worker is sometimes very sharp, particularly in marginal cases. For example, if the efficiency of a worker falls even slightly below the standard, he is heavily penalised but as soon as he reaches the standard or even slightly exceeds it, the reward is substantial. The Merrick differential piece-rate system smoothens such sharp differences through three gradual rates

In this system, there are three piece-rates for a job but unlike the Taylor system there is no punitive rate, i.e. none of the rates is fixed below the normal. The rates are applied as under :

Efficiency	Piece-rate applicable
up to 83 $\frac{1}{3}$ %	Normal rate
up to 100%	10% above normal rate
above 100%	30% above normal rate

Under this method also, day wages are not guaranteed. The standard set is very high but once a worker reaches the standard, he gets high wages.

Gantt Task Bonus Wage System. This system is a combination of time-work and piece-work and unlike the Taylor and Merrick plans, day wages under this system are guaranteed. A high standard or task is set and payment is made at time-rate for production below the standard. If the standard is achieved or exceeded, payment is made at a high piece-rate. The piece-rate is so fixed as to include a bonus of 20% over the time-rate of the worker. If the standard for a job is fixed, say at 80% efficiency and the piece-rate is Re. 0.30 per piece or unit, a worker whose hourly rate of pay is Rs. 2.40 will be paid as follows :

Below 80% efficiency	Rs. 2.40 per hour
At 80% efficiency and above	Rs. 2.40 + 20% of Rs. 2.40
	= Rs. 2.88 per hour
	or Re. 0.30 + 20% of Re. 0.30
	= Re. 0.36 per piece (High piece-rate)

The earnings of the worker and the labour cost per unit under this method at various levels of efficiency are illustrated below :

Efficiency %	Production per hour (units)	Wage rate per hour (Rs)	Total wages paid per hour (Rs)	Labour cost per unit (Rs)
40	4	2.40	2.40	0.600
50	5	2.40	2.40	0.480
60	6	2.40	2.40	0.400
70	7	2.40	2.40	0.343
80 (Standard)	8	2.40	2.88	0.360
100	10	2.40	3.60	0.360
120	12	2.40	4.32	0.360

It will be seen from the above that the labour cost per unit is reduced as efficiency approaches the standard. At standard efficiency, however, there is a slight increase in unit cost which is maintained uniformly for all higher levels of efficiency.

Emerson Efficiency or Empiric System In this system, the standard of efficiency is set at $66\frac{2}{3}\%$ or 67% . The worker gets his guaranteed day rate for efficiency up to the standard ; at higher efficiency levels, he is entitled to a bonus. The bonus payable at efficiency levels above 67% is computed as percentage of the hourly rate (10% in the example below). It increases progressively with increase in efficiency in such a manner that at 100% efficiency, the bonus is 20% of the hourly rate. For efficiency beyond 100% , the bonus increases at a faster rate, an additional 1% bonus is added for each increase of 1% in the efficiency beyond 100% . Thus at 130% efficiency, the bonus is 50% ($20\% + 30\%$). A chart showing the wage payment at various levels of efficiency, is given below :

Production units	Standard hours allowed	Actual hours taken	Efficiency %	Basic hourly rate of pay	Bonus	Hourly rate after inclusion of bonus	Total wage payment (cost per 100 units)
100	10	25.00	40	Rs. 2.40	% —	Rs. 2.40	60.00
100	10	20.00	50	2.40	—	2.40	48.00
100	10	15.00	67	2.40	—	2.40	36.00
100	10	12.50	80	2.40	10%	2.64	33.00
100	10	10.00	100	2.40	20%	2.88	28.80
100	10	8.33	120	2.40	40%	3.36	27.99
100	10	7.70	130	2.40	50%	3.60	27.72

(In certain cases the hours saved are also paid at the time rate, in addition to the bonus.)

The bonus is usually calculated on the combined efficiency achieved for all the jobs in a wage period taken together and not individually for each job. Efficiency for this purpose is calculated in the following manner (on time basis) :

$$\text{Efficiency \%} = \frac{\text{Total Standard time allowed for all jobs done in a period} \times 100}{\text{Total time taken for all jobs done in the period}}$$

When calculations are made periodically, inefficiency or slow work in respect of some jobs reduces the high bonus gained by efficient work on other jobs. The worker is thus compelled to work at a uniform rate and slow work is avoided.

The *disadvantage* of this method is that up to the standard efficiency, there is no incentive and even beyond the standard, the incentive is not appreciable enough. The result is that the average worker is satisfied with his guaranteed day rate and whatever bonus he is able to earn for efficiency between 67% and 100%.

Premium Bonus Plans. In the time-rate method of payment, the disadvantages arising out of slowness or inefficiency of workers are borne by the employer alone. Similarly any gains due to the efficiency of time workers go entirely to the employer and the workers are not benefited. In the piece-work system, the efficiency or otherwise of the workers does not affect the employer in so far as the unit labour cost is concerned. If an efficient piece-worker is able to increase his output, he derives full benefit thereof in the shape of increased wages and the employer is benefited by reduction in overhead cost per unit. Premium bonus plans differ from the systems mentioned above in that the financial advantage on account of the efficiency of the worker is shared between the employer and the employee, in agreed proportions. There are several methods under the premium bonus plans but the basic principles underlying all these methods are practically the same and it is only in the manner of sharing between the employer and employees that they differ from one another.

Another feature of the premium bonus plans is that they regulate or moderate the speed of work so that the worker does not tend to slow down as in the case of time rate system nor does he attempt to speed up to cause breakdown of machines or spoilage of work as in the piece-rate system.

Under premium bonus plans, standard time is set for doing a task. The worker is guaranteed his day wages (except in Barth system), and so long as his output is below and up to standard, he is paid at his daily rate. If the task is completed in less than the standard time, the time saved is shared between the employer and the employee.

— Basically there are two types of bonus plans, viz. *constant sharing plans* and *variable sharing plans*. In constant sharing plans, the factor, i.e. the proportion in which the saving is shared, is constant for all levels of efficiency. In the other type of plans, the factor varies with the time saved.

The earning of a worker in premium bonus plans is calculated in accordance with the following formula :—

Standard time set for task	= T_s hours
Actual time taken to complete task	= T_a hours
Time saved	= $(T_s - T_a)$ hours

Time rate of wages	=Rs. R per hour
Proportion of sharing (Factor)	=Rs. F per hour
Earning = $T_a \times R + (T_s - T_a) \times F \times R$	
When time saved is nil, i.e. $T_a = T_s$; Earning	= $T_a \times R$
(This can be compared with the piece work system where $F = 100\%$ for the employee ;	
Earning = $T_a \times R + (T_s - T_a) \times R = T_s \times R$, (i.e. maximum wages.)	

The distinction between premium bonus and efficiency bonus should be noted. The former is a system of initial remuneration for a direct worker who completes the job in less than the allotted time whereas efficiency bonus is the additional remuneration that may be paid to direct as well as indirect workers and to supervisors also.

For a comparative study of the earnings under time rate, piece-work, and premium bonus systems at different levels of efficiency, reference may be made to Figs. 3.13 and 3.14.

Halsey Premium System (Constant Sharing Plan). Under this system, if the actual time taken is equal to or more than the standard time, the worker is paid at the time-rate. Thus for inefficient work, the worker is not penalised and he gets his day wage for the hours worked. If the time taken is less than the standard, the time saved is shared by the worker and the employer. In addition to time wage for the hours actually worked, the worker gets a bonus payment of a percentage of the time saved, calculated at his time rate. The percentage allowed to the worker varies from 30% to 70% (usually 50%).

Standard time allowed	-- 10 hours
Actual time	-- Worker A : 12 hours
	.. B : 10 hours
	.. C : 7 hours

Hourly rates of wages -- Rs. 3 for each worker

Wages for A : (Rs. 3 \times 12) = Rs. 36 (No bonus, only guaranteed day rate)

Wages for B : (Rs. 3 \times 10) = Rs. 30 (No bonus, only guaranteed day rate)

Wages for C : (Rs. 3 \times 7) + Rs. 3 \times $1\frac{1}{2}$ hours = Rs. 25.50 (Time saved is 3 hours)

Calculation of wages under this system is further illustrated below :

EXAMPLE 3.2.

An operator engaged in machining certain components receives an ordinary day rate of Rs. 16 per day of 8 hours. The standard output for machining the components has been fixed at 80 pieces per hour (time as fixed for premium bonus). On a certain day, the output of the worker on this machine is 800 pieces. Find the labour cost per 100 pieces and the wages that would have been actually earned by the workman under the following :—

- If a bonus of Rs. 2.30 is paid per 10% of the extra output.
- If paid for on straight piece-work basis at the standard rate.
- If Halsey Premium Bonus system is being adopted.

(J. C. W. A., Inter)

ANSWER :

(a) Time rate per day for 640 pieces in 8 hours	Rs. 16.00
Bonus for extra output of 160 pieces ($\frac{2.3}{100} \times 160$)	Rs. 3.68
Total wages for 800 pieces	Rs. 19.68
Labour cost per 100 pieces	Rs. 2.46
(b) Piece rate for 640 pieces	Rs. 16.00
Wages for 800 pieces	Rs. 20.00
Labour cost for 100 pieces	Rs. 2.50

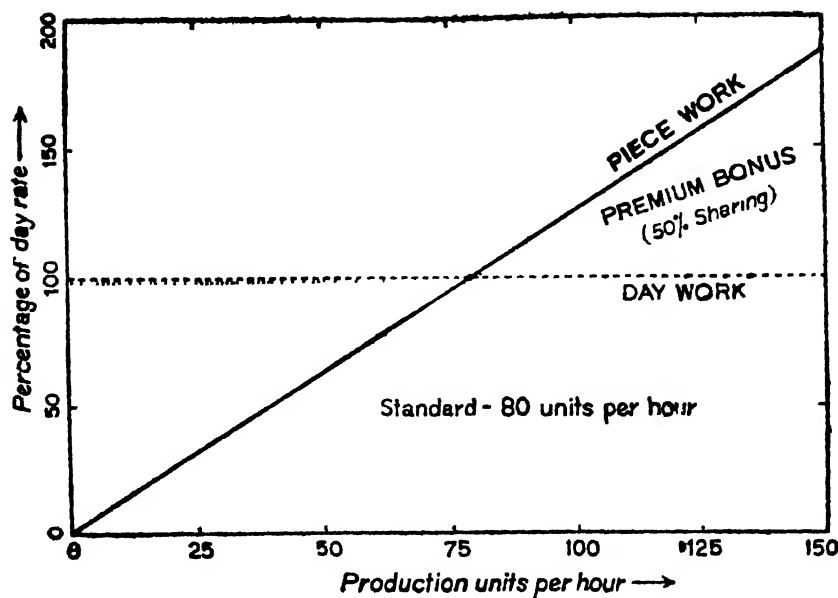


Fig. 3.13. Comparative earnings under Time-rate, Piece-rate, and Premium Bonus Plans

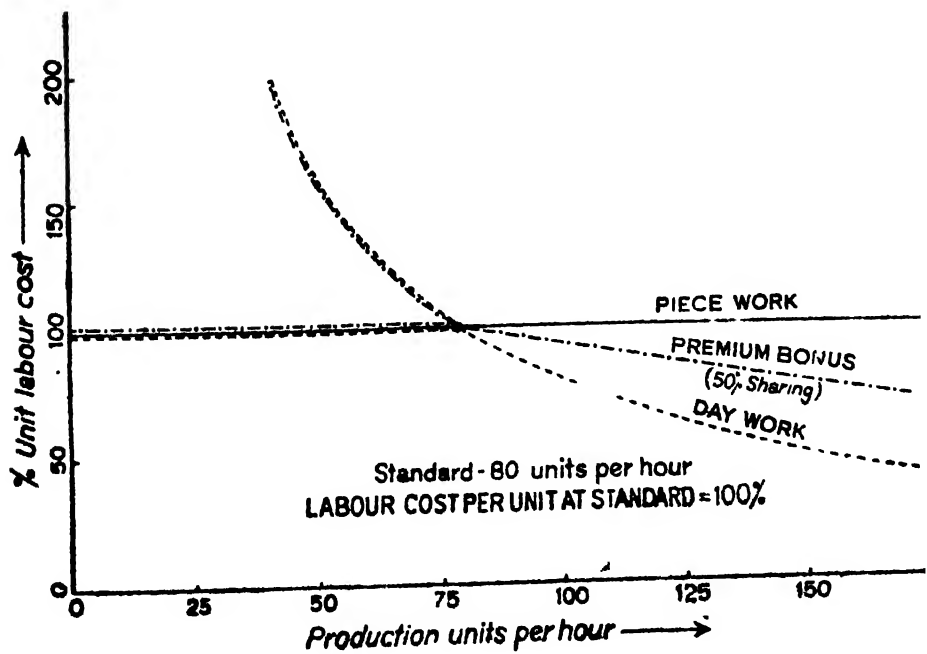


Fig. 3.14. Unit labour cost under Time-rate, Piece-work and Premium Bonus Plans

(c) Time-rate per day for 640 pieces in 8 hours	Rs. 16.00
Bonus for half of 160 pieces (i.e. 80 pieces)	Rs. 2.00
Total wages for 800 pieces	Rs. 18.00
Labour cost for 100 pieces	Rs. 2.25

EXAMPLE 3.3.

Jobs are issued to operative X, to make 189 units and to operative Y, to make 204 units for which a time allowance of 20 standard minutes and 15 standard minutes per unit respectively is credited. For every hour saved, bonus is paid at 50% of the base rate, which is Rs. 3 per hour for both employees. The basic working week is 42 hours. Hours in excess are paid at time plus one third.

X completes his units in 45 hours and Y completes his units in 39 hours (but works a full week). Due to defective material, six of X's units and four of Y's units are subsequently scrapped, although all units produced are paid for.

You are required to calculate for each of X and Y,

- the amount of bonus payable,
- the total gross wages payable,
- the wage cost per good unit made.

(I C M A, Inter-Adapted)

ANSWER

Operator	X	Y
(a) Production units	189	204
Time allowance	$189 \times 20/60 = 63$ hours	$204 \times 15/60 = 51$ hours
Actual time taken	45	39
Time saved	18	12
Bonus (50% of Rs. 3, i.e. Rs. 1.50 per hour)	Rs. 27	Rs. 18
(b) Wages for week	$42 \times \text{Rs. } 3 = \text{Rs. } 126$	$39 \times \text{Rs. } 3 = \text{Rs. } 117^*$
Bonus	Rs. 27	Rs. 18
Overtime ($1\frac{1}{3}$ of 3 hours = 4 hours)	Rs. 12	—
	Rs. 165	Rs. 135
(c) Units produced	189	204
Less scrap	6	4
	183	200
Wages cost per unit	Re. 0.90	Re. 0.675

*Note : Although the basic working week is 42 hours, Y is paid for 39 hours on the assumption that he has been employed and paid for 3 hours on some other job. If he had been idle and his weekly wages were guaranteed, he should be paid Rs. 126 instead of Rs. 117 as his basic wages for the week.

Rowan System of Premium Bonus (Variable Sharing Plan). As in Halsey system, the day wages are guaranteed in the Rowan system; a standard is set for a task and bonus is paid on the time saved. The amount of bonus paid is a percentage of the hourly rate which is in proportion to the time saved. With the data assumed on Page 138 the bonus percentage for the worker C will be calculated as follows :—

$$\frac{\text{Time saved}}{\text{Standard time}} = \frac{3 \text{ hours}}{10 \text{ hours}} = 30\%$$

$$\text{Hourly rate inclusive of bonus} = \text{Rs. } 3 + 30\% \text{ of Rs. } 3 = \text{Rs. } 3.90$$

$$\text{Total wages} = \text{Rs. } 3.90 \times 7 = \text{Rs. } 27.30$$

$$(\text{or } \text{Total wages} = \text{Rs. } 3 \times 7 + \frac{3}{10} \times 7 \times \text{Rs. } 3 = \text{Rs. } 27.30)$$

$$\text{Formula for wages} = T_s \times R + \frac{T_s - T_a}{T_s} \times T_a \times R$$

EXAMPLE 3.4.

An employee working under a bonus scheme saves 4 hours on a job for which the standard time is 32 hours. Calculate the rate per hour worked and wages payable for the time taken under the following alternative schemes (award rate is Re. 1 per hour).

(i) Employee receives an increase in the hourly rate based on the percentage that the time saved bears to the time set.

(ii) A bonus of 10% on award rate is payable when standard time (i.e. 100% efficiency) is achieved plus a further bonus of 1% on award rate for each 1% in excess of 100% efficiency.

(I. C. W. A., Inter)

ANSWER :

(i) Standard time 32 hours

Actual time 28 hours

Time saved 4 hours

$$\text{Wages payable} = (28 + \frac{28 \times 4}{32}) \times \text{Re. 1} = \text{Rs. 31.50}$$

$$\text{Rate per hour} = \frac{\text{Rs. 31.5}}{28} = \text{Rs. 1.125}$$

(ii) Standard time 32 hours or 100% efficiency

Actual time 28 hours, i.e. $32/28 \times 100$ or 114% efficiency

Wages payable : Actual time 28 hours @ Re. 1 Rs. 28.00

Bonus 10% (for achieving 100% efficiency) Rs. 2.80

Additional bonus 14% (14% for each 1% in excess of 100% efficiency) Rs. 3.92

Total Rs. 34.72

$$\text{Rate per hour} = \frac{\text{Rs. 34.72}}{28} = \text{Rs. 1.24}$$

EXAMPLE 3.5.

In a factory two workmen A and B produce the same product using the same material. Their normal wage rate is also the same. They are paid bonus according to the Rowan System. The time allotted to the product is 40 hours. A takes 25 hours and B takes 30 hours to finish the product. The factory cost of the product for A is Rs. 193.75 and for B, Rs. 205. The factory overhead rate is one rupee per man-hour. Find the normal rate of wages and the cost of materials used for the product.

(I. C. W. A., Inter)

ANSWER :

If W be the rate of wages per hour and M, the cost of material,

Factory Cost A (Rs. 193.75) :

$$\text{Labour} = (25 + \frac{25}{40} \times 15) W$$

$$\text{Material} = M$$

$$\text{Overhead} = 25 \times \text{Re. 1} = \text{Rs. 25}$$

$$(25 + \frac{25}{40} \times 15)W + M + 25 = 193.75 \quad \dots \dots \dots (i)$$

Factory Cost B (Rs. 205) :

$$\text{Labour} = (30 + \frac{30}{40} \times 10)W$$

$$\begin{aligned} \text{Material} &= M \\ \text{Overhead} &= 30 \times \text{Re. } 1 = \text{Rs. } 30 \\ (30 + \frac{30}{40} \times 10)W + M &= 30 + 205 \end{aligned}$$

Solving equations (i) and (ii),
 $W = \text{Rs. } 2$ per hour
 $M = \text{Rs. } 100$

A comparative study of the wages under the Rowan and Halsey plans (see Fig. 3.15) will show that when the time saved is less than 50% of the standard time, Rowan system allows more wages payment to the worker than the Halsey system. If the time saved is more than half of the standard time, this additional advantage to the worker under the Rowan system is lost and with the increase in time saved, there is a gradual reduction in the bonus though the wage cost per hour continues to increase. It will also be seen that in the Rowan system a less efficient worker gets the same bonus as a more efficient worker. As will be seen from the following table, a worker who does the work in 6 hours gets the same bonus, i.e. Rs. 4.80 which is earned by a worker completing the task in only 4 hours. From the management point of view, the Rowan system, therefore, provides a safeguard in case of any loose fixation of the standards. The fall in bonus as time saved increases sets off to a large extent the damage done by the loose standards.

Standard time—10 hours Day rate—Rs. 2 per hour

Time taken (Hours)	Time saved (Hours)	Basic time wages (Rs.)	Halsey System			Rowan System		
			Bonus (Rs.)	Total earning (Rs.)	Earning per hour (Rs.)	Bonus (Rs.)	Total earning (Rs.)	Earning per hour (Rs.)
15	—	30	—	30	2.00	—	30.00	2.00
12	—	24	—	24	2.00	—	24.00	2.00
10	—	20	—	20	2.00	—	20.00	2.00
8	2	16	2	18	2.25	3.20	19.20	2.40
6	4	12	4	16	2.67	4.80	16.80	2.80
5	5	10	5	15	3.00	5.00	15.00	3.00
4	6	8	6	14	3.50	4.80	12.80	3.20
3	7	6	7	13	4.33	4.20	10.20	3.40

Fig. 3.15. Earnings under Halsey and Rowan Plans

EXAMPLE 3.6

The standard time for a job is 60 hours. The hourly rate of guaranteed wages is Re 0.75. Because of the saving in time, a worker A gets an hourly wage of Re 0.90 under Rowan Premium Bonus system. For the same saving in time, calculate the hourly rate of wages a worker B will get under Halsey Weir Premium Bonus system assuring 40% to worker (I.C.W.A., Inter)

ANSWER :

If the actual time taken be T hours, total wage, under Rowan system is

$$\left\{T + \frac{T}{60}(60 - T)\right\} \times 0.75$$

But total wages is also = $T \times 0.90$

$$\therefore \left\{T + \frac{T}{60}(60 - T)\right\} \times 0.75 = T \times 0.90$$

From the above equation, we get $T = 48$ hours

\therefore Time saved = $60 - 48 = 12$ hours

Under the Halsey system with 40% share for the worker,

Total wages = $48 \times 0.75 + \frac{40}{100} 12 \times 0.75$ Rs. 39.6

Hourly rate of wages = $\frac{39.6}{48} = \text{Rs. } 0.825$

Barth Premium System (Variable Sharing Plan). Unlike the two premium bonus systems described above, the Barth Plan does not provide for a guarantee of the minimum day wages of a worker. To arrive at the wages payable under this plan, the hourly rate of pay is multiplied by the square root of the product of the standard time and the time taken.

Wages = $\sqrt{\text{Standard time} \times \text{Actual time}} \times \text{daily rate, i.e., } \sqrt{T_s \times T_a} \times R$

With the data assumed in the previous examples, the wages for the three workers, A, B, and C will be as follows :

		Wages	Labour cost per hour
Worker A	$\sqrt{10 \times 12} \times \text{Rs. } 3$	Rs. 32.80	Rs. 2.73
Worker B	$\sqrt{10 \times 10} \times \text{Rs. } 3$	Rs. 30.00	Rs. 3.00
Worker C	$\sqrt{10 \times 7} \times \text{Rs. } 3$	Rs. 25.10	Rs. 3.60

The system is particularly suitable for trainees and beginners and also for unskilled workers. The reason is that for low production efficiency, the earnings are higher than in the piece-work system but as efficiency increases, the rate of increase in the earnings falls. The system is, therefore, not suitable for a high task where skilled workers are employed for giving high production. Another disadvantage of the Barth system is that the calculations are slightly complicated and difficult for the average worker to understand or to calculate his earnings himself.

The earnings at various levels of efficiency, under the Halsey, Rowan, and Barth systems have been illustrated in the graph in Fig. 3.10.

In actual practice, a concern may adopt one or the other of the incentive systems described in this chapter or from out of these systems, it may evolve a procedure of its own to suit its specific requirements. Two examples are given below to illustrate such tailor-made systems.

EXAMPLE 3.7.

A manufacturing concern desires to introduce an incentive system based on the reduction of labour and overhead costs of a product. The following scales of payment of bonus to workers are proposed :

Reduction up to 25% earns a bonus of 10% of wages

" " 35% " " " 20% "

" " 50% " " " 30% "

With the following data, work out the earnings of two workers, W_1 and W_2 for every 100 units of output.

Standard conversion cost (labour and overhead) of the product—Rs. 6 per unit

Overhead percentage : 200% on wages cost

Wage rate : W_1 —Rs. 0.80 per hour ; W_2 —Rs. 0.75 per hour

Time taken for completion of 100 units : W_1 —200 hours ; W_2 —180 hours

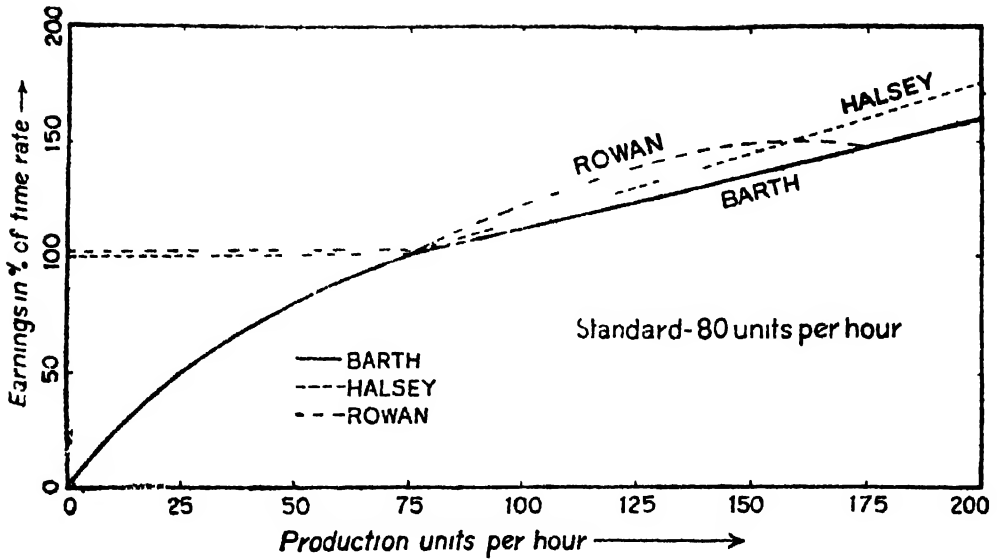


Fig 3 16 Comparison of earnings under Halsey, Rowan, and Barth Systems

ANSWER

	W_1	W_2
Time taken	200 hrs.	180 hrs
Wage rate per hour	Re. 0.80	Re. 0.75
Wage cost	Rs 160	Rs 135
Overhead cost	Rs 320	Rs 270
Total	Rs 480	Rs. 405
Standard cost	Rs 600	Rs. 600
Reduction in cost	Rs 120	Rs 195
Percentage of reduction	20%	32.5%
Bonus on wages	10%	20%
Bonus amount	Rs. 16	Rs. 27
Total earnings	Rs. 176	Rs. 162

EXAMPLE 3.8.

Payment of wage bonus is made in a concern on the following scale on the basis of the percentage of time saved on time allowed

Time saved (% of Standard)	Bonus (% of time saved)
Upto 25%	10%
Above 25% and up to 35%	(i) Plus 20% of time saved above 25% and up to 35%
Above 35%	(ii) Plus 30% of time saved beyond 35%

Calculate the earnings of a worker (wage rate Rs. 1.20 per hour) who takes 50 hours to complete a job the standard allowed time for which is 100 hours
(I. C. W. A., Inter)

ANSWER :

Standard	: 100 hours	
Actual	: 50 hours	
Time saved	: 50 hours	
% of time saved to time allowed	: 50%	
		Rs.
Basic Wage	: 50 hours \times Rs. 1.20	= 60.00
Bonus 1st slab	: 25 hours \times Rs. 1.20 \times 10%	= 3.00
2nd slab	: 10 hours \times Rs. 1.20 \times 20%	= 2.40
3rd slab	: 15 hours \times Rs. 1.20 \times 30%	= 5.40
Total earnings		Rs. 70.80

Bedaux System. The standard for a job is fixed under the Bedaux system in terms of points or units, termed 'b' units. The underlying principle is that the worker's efforts can be measured in terms of a common denominator made up of periods of work followed by necessary periods of rest, the extent of the latter being dependent upon the efforts put in for the work. For example, when we say that the time allowed for doing a work is one minute, it would mean that only a part of the allowed minute consists of work and the balance is meant for relaxation and rest, the proportion between the two varying according to the nature of the work. One job may require half a minute for work and half a minute for rest ; another job may need three-fourths of a minute for work and one-fourth of a minute for rest. But in both the cases, the total effective time set as the standard is the same, i.e. one minute. One 'B' unit represents the amount of work that an average man can do under ordinary conditions in one minute allowing for the relaxation needed. The standard time for a job is determined by work study and each job is assigned the requisite number of B's. Thus, if a job requires two seconds for work and the allowance for relaxation is 50%, the effort value of the job in terms of 'B' will be calculated as follows : —

$$\frac{2 \text{ seconds of work} + 1 \text{ second of rest}}{60} = \frac{3}{60} = 0.05 \text{ units 'B'}$$

An average worker should, therefore, earn 60 B's per hour without any extra effort on his part and irrespective of the nature of the work done. For work up to 60 B's per hour, he is paid at his hourly rate ; work beyond 60 B's per hour entitles him for bonus and is termed bonus or premium units. The bonus is usually paid at the rate of 75% of the premium 'B' earned ; the balance 25% is either retained by the employer or paid to indirect workers or supervisors. Some concerns pay 100% of the B's earned in which case a worker gets the same payment as he will get in the ordinary piece-work system. The method of calculation of wages under the Bedaux system is shown overleaf. (*The basic data assumed for illustrating the premium bonus system on Page 138 have been taken.*)

Standard time = 10 hours
 Therefore, Standard Units of 'B' = $10 \times 60 = 600$
 Hourly rate = Rs. 3

$$\text{Rate for one 'B'} = \frac{\text{Rs. 3}}{60} = \text{Re. 0.05}$$

Worker A : Actual time = 12 hours

$$\text{Rate of 'B' earned} = \frac{600}{12} = 50 \text{ per hour}$$

This being less than 60, no bonus is admissible.

$$\text{Wages} = \text{Guaranteed day wage} = \text{Rs. } 3 \times 12 = \text{Rs. } 36$$

Worker B : Actual time = 10 hours

$$\text{Rate of 'B' earned} = \frac{600}{10} = 60 \text{ per hour}$$

As this is the standard, no bonus is admissible.

$$\text{Wages} = \text{Guaranteed day wage} = \text{Rs. } 3 \times 10 = \text{Rs. } 30$$

Worker C : Actual time = 7 hours

$$\text{Rate of 'B's earned} = \frac{600}{7} = 85.7 \text{ per hour}$$

$$\text{'B's earned for 7 hours} = 600$$

$$\text{Standard 'B's for 7 hours (7} \times 60) = 420$$

$$\text{Extra 'B's} = 180$$

$$\text{Premium 'B's} = 75\% \text{ of } 180 = 135$$

$$\text{Total 'B's payable} = 420 + 135 = 555$$

$$\text{Wage} = 555 \times \text{Rs. } 0.05 = \text{Rs. } 27.75$$

$$\text{Wages per hour} = \frac{\text{Rs. } 27.75}{7} = \text{Rs. } 3.96$$

The *advantages* of the Bedaux system are :

- (i) The measurement of output in terms of a common unit provides an easy method of recording production of each worker and comparing it with the standard.
- (ii) The system provides suitable data for production control.
- (iii) The 'B' units may be used for controlling the worker's time and machine time.
- (iv) Sometimes the Bedaux system may be extended to the department as a whole, including indirect workers. Payment is made on the basis of points earned by the entire department.

The *disadvantages* are :

- (i) Detailed calculation of 'B' units for a large number of jobs involves heavy clerical expenditure. The system is, therefore, costly.
- (ii) In common with other premium bonus systems, part of the reward for increased efforts goes to the employers. The wage earned by a worker under this system is thus always less than that in the piece-work method.

Haynes System. This is similar to Bedaux Plan with some distinct features as noted below :

- (a) Instead of B units, the standard minute used to measure work is called 'Manit' (an abbreviation for man-minute).

- (b) 50% of the bonus earned goes to workers, 10% to supervisors and the balance 40% is retained by the employer.

Accelerated Premium Systems. Under these systems, earnings increase with output ; the rate of increase itself increases progressively with output. This provides strong incentive for skilled workers to earn very high wages by increasing production and for production beyond standard, the earnings increase in greater proportion than the increase in production. Accelerated premium systems are, however, complicated in operation and are difficult for the workers to understand.

Group Systems of Wage Payment. There are certain jobs or operations which are required to be performed collectively by a number of workers. In some cases, the job consists of several operations each of which is performed by a different worker but the operations are so interlinked that the entire job can be done only by the combined efforts of a group of workers. In the conveyor belt system for instance, where the work flows in a sequence, or in mass production or assembly work for radios, automobiles and such other industries, a team of workers is engaged on the various operations. A man's work depends on the work done by one or more of his colleagues and as such it is not possible to measure separately the output of each individual worker. The workers constituting a team or group are, therefore, considered as a composite unit and the combined output of this unit is measured for the purpose of wage payment.

Although most of the systems of remuneration can be applied for payment to a group, the commonly adopted systems are the piece work, Bedaux, and Halsey or Rowan premium bonus plans. The earning of a group is determined in accordance with any of these methods adopted and is distributed among the members of the group on an equitable basis. The following methods of distribution are commonly used :—

- (i) Equally, if all the workers of the team are of the same grade and skill and have the same rate of pay and same hours of work.
- (ii) Prorata to the time rate of each worker where the time put in by individual members is the same.
- (iii) On the basis of the time rates and attendance of each worker. The time rate of a worker is multiplied by his attendance to arrive at his 'nominal or notional' day wages, i.e. the wages he would have received had he been on time rate. The earning of the group is then distributed on the basis of the nominal day wages of each worker. This is illustrated below :

Method of remuneration : Piece work

Group consists of 4 workers, A, B, C and D.

Output of the group—15,000 units

Piece rate—Rs. 10 per 100 units

Attendance—200, 100, 150 and 200 hours for A, B, C and D respectively

Time-rate per hour—Rs. 2.00, Rs. 2.50, Rs. 1.50 and Rs. 2.50 for A, B, C and D respectively

Total Piece earning of the group $= \frac{15,000}{100} \times \text{Rs. 10} = \text{Rs. 1,500}$

Total Nominal wages of the group		=Rs. 400+ Rs. 250+Rs. 225+ Rs. 500
		=Rs. 1,375 (For A : 200 hrs. \times Rs. 2 00= Rs. 400, and so on for B, C and D)
Wages payable to worker A	=Rs. $\frac{1,500}{1,375}$	$\times 400$ =Rs. 436.35
B	=Rs. $\frac{1,500}{1,375}$	$\times 250$ =Rs. 272.75
C	=Rs. $\frac{1,500}{1,375}$	$\times 225$ =Rs. 245.45
D	=Rs. $\frac{1,500}{1,375}$	$\times 500$ =Rs. 545.45
Total		Rs. 1,500 00

- (iv) On a specified percentage basis ; the percentage applicable to a worker is pre-determined on the basis of his skill, rate of pay, etc.
- (v) In a mixed gang of unskilled and skilled workers, a method of distribution is to pay the unskilled workers at their time rates. The balance amount remaining out of the total earnings after payment to the unskilled workers is distributed amongst the skilled workers by any of the methods discussed above.

Group system of payment offers the following *advantages* :—

- It encourages co-operation and team work among the workers, thus leading to increase in productivity and improved labour relations.
- Absenteeism is reduced.
- A less efficient worker is automatically marked or pulled up by the efficient workers of the group. This trims supervision costs.
- Routing and scheduling routines are simplified.
- The system requires less clerical work and the use of forms and records is reduced because the production of the group and not of the individual workers is to be recorded. This simplifies costing.

Disadvantages of the group system are as follows :—

- Care is necessary for the selection of the workers who are to constitute a group. If the composition of the group is heterogeneous, with extreme variations in the degrees of skill, efficiency, and seniority of the individual workers, or if fast and slow workers are teamed, there is likely to be some discontent.
- An efficient worker is penalised for the inefficiency of other members of the group.
- It creates a problem when a fairly big job remains incomplete at the end of the wage period. Such a difficulty may also arise in the case of individual systems of payment by results and can be solved by assessing the percentage of completion : proportionate payment may be made according to this percentage.

- (d) Rivalry among the members of the group may defeat the very purpose of teamwork and co-operation.

Rationale of Payment of Guaranteed Wages. We have seen that several of the incentive wage payment systems offer a guarantee of minimum day wages to the worker. Prima-facie, this would appear to put a premium on inefficient work but the following considerations will indicate the usefulness of a properly controlled guarantee system from the points of view of both the employers and the employees :

- (a) A worker cannot be expected to work at top speed at all times and a guaranteed payment is necessary when for some reason, output falls. For example, when a worker returns from sick leave, he may not be able to attain average speed for some time ; the guarantee in such a contingency proves useful.
- (b) This gives a sense of security of wages and labour turnover is kept low. Morale of the workers is high.
- (c) When put on incentive production work, trainees and new comers are not able to earn sufficient wages in the beginning and are in need of the guarantee.
- (d) Production may fall for reasons beyond the control of the worker, e.g. when there is a reduction in speed due to machine fault.

A watch should, however, be kept on guarantee payments so that suitable action can be taken in cases where workers have to be constantly paid only the guaranteed wages.

Collective Production Bonus Schemes. There are several such schemes in use.

In the *Priestman system*, bonus is paid on a collective basis not only to workers but to all the staff in the factory. A standard for production is fixed for the factory as a whole. In case of mixed production where various products are manufactured, this standard is fixed on points basis. When actual production exceeds the standard, bonus is paid to all the employees by increasing their normal wages by the same percentage as the increase in production. If there is an increase of 10% in production over the standard, each individual will get his normal pay plus a bonus at the rate of 10% of his pay. As the method deals with payment of bonus only, this is strictly speaking not a distinct system of payment of wages.

Under the *Cost Premium System*, payment is made on an agreed basis for saving in costs effected for the factory as a whole. Thus, the payment of premium is dependent not only on the labour output but also on economy achieved in the use of materials and services. The incentive offered in this system is too remote and has no direct relation with the efforts of the worker or with his normal rate of pay.

Incentive Systems for Indirect Workers. We had seen that the main condition for an incentive system is that accurate measurements of the time required and of the time taken for a job should be possible. As setting of task standards and measurement of output is not an easy matter in respect of indirect work like

maintenance, internal transport, inspection, packing, and cleaning, introduction of a system of payment by results for indirect workers is difficult. In spite of the difficulty involved, it becomes necessary to provide for incentives to such workers for the following reasons :—

- (a) Payment of time rate to indirect workers and giving incentive bonus to direct workers who are working side by side, leads to dissatisfaction and labour unrest.
- (b) It is but logical to say that indirect workers are as much entitled to bonus as the direct workers.
- (c) Payment of bonus to indirect workers creates team spirit.
- (d) An incentive system for indirect workers assists in maintaining the efficiency of important services such as plant repairs, stores maintenance and control, materials handling, etc.
- (e) In a case where the work of the direct workers is dependent upon the service rendered by the indirect workers, any deficiency of the latter due to lack of incentive lowers the efficiency of direct workers.

The following arrangements may be made for introducing incentive systems and payment of bonus to indirect workers :—

- (a) For work of a repetitive nature such as periodical check up, cleaning and overhaul of plant and machinery, standard packing work, and white washing of specified areas of buildings, it is possible to measure the functions performed and to fix up allowed time or standards. In such cases the introduction of a suitable incentive system is not difficult.
- (b) Where possible, indirect workers like helpers, carriers of materials, packers, etc. may be included in a collective plan along with the skilled workers and paid proportionately, out of the bonus earned by the whole group.
- (c) Indirect workers may be paid bonus on the basis of the output of a group of direct workers of a production shop, or of the factory as a whole, depending upon whether the indirect workers render service to a group, to a shop, or to the entire factory. Maintenance workers attached to a production section may be paid a stipulated percentage of the total bonus earned by all the direct workers in that section.
- (d) By job evaluation and application of merit rating system to indirect workers.
- (e) Application of arbitrary methods. One such method is to pay deliberately high day-rates to skilled maintenance workers so as to include an element of bonus in the rate itself.
- (f) Incentives may be based on savings of the actual expenses over the budgeted expenses.
- (g) Payment of incentive according to the ratio between direct and indirect labour hours.

Methods of incentive payments to various types of indirect workers are discussed below :

Application of incentive scheme to materials handling staff: Incentives may be based on the number of items of materials handled. Standard hourly rates may be established for carrying each kind of material based on the time and distance involved. If such detailed accounting for measuring efficiency is not practicable, a monthly overall bonus related to the efficiency of performance may be computed.

Incentive for maintenance and repairs staff: In mass production work, majority of the repair and maintenance duties can be considered as routine and repetitive for which efficiency percentage can be evaluated. However, if such evaluation is not possible or practicable, a group bonus system can be established on the basis of reduction in breakdown or on the number of complaints.

Incentive for stores staff: Incentives may be based on the number of requisitions handled. Some suitable standard may be established and actual performances in aggregate, compared on a percentage basis. Incentive payment may be related to this percentage.

Incentive for inspection staff: In mass production conditions, routine inspection work can be standardised and even piece-rates may be established for it. Otherwise, a group bonus can be computed each month by comparing the aggregate efficiency with the pre-determined standards.

Incentive for office staff: Job evaluation may be done for each item of office work and a bonus may be fixed on the basis of performance for reduction of overtime work, for maintaining schedules, and for clearance of arrears of work.

Incentive for supervisors and executives: Supervisors, foremen, and executives form an important link between the workers and the high level management. Incentive for such staff should assist in maintaining efficiency all round by avoiding idle time and excess spoilage, wastage, and scrap, increasing production and productivity, and ultimately reducing costs. Incentives to supervisors and executives usually take the form of non-financial benefits. Where standard costing or budgetary control system is in vogue, bonus may be calculated on the basis of savings over the standards or the budgets or on the basis of overall improvement of efficiency. Standards may be set for such factors as units of output, level of expenditure, quality of products, wastage and scrap, and labour turnover.

Cost Efficiency Bonus Plan (or Cost Saving Plan). Under this system, the amount of bonus is calculated when the cost is reduced below the normal established target. The plan may be restricted to indirect workers and supervisors or applied to all. The cost for which reduction is expected may be in respect of only labour or both labour and material.

In a process industry, the normal cost per unit of a product is already established and the norm is known to all the staff in a department. When the actual performance shows a saving in the total labour and material costs or a reduction in the total cost per unit, a fair percentage of the saving is distributed amongst the staff. Three popular American plans are briefly described here.

Nunn-Bush Plan : A norm of direct labour cost is fixed and expressed as a percentage of the sales value. A fund is created by crediting the total normal labour cost. The fund is debited with the actual wages incurred by the factory. Credit balances, if any, are distributed regularly between the staff and the workers on a suitable basis.

Scanlon Plan : In this method also, a fund is created by crediting the normal cost of wages and salaries to which the actual labour costs are debited. An amount up to two-thirds or three-fourths of the credit balance is regularly distributed as bonus, the balance being reserved for future set-backs.

Rucker Plan : This is similar to Nunn-Bush Plan except that the percentage for crediting the fund is based on the total value added by manufacture (i.e. the total cost less the value of the material) and not on total sales value.

Sometimes a peculiar situation arises when incentives for increased output and reduction of material waste operate at one and the same time. In his effort to increase the output, the worker increases wastes but on the other hand, if he gives more attention to waste reduction, his output falls. Between the two opposing factors, he would naturally tend to choose the one which gives him more monetary advantage, if the two incentives are not on the same scale. A better system in such cases is to link the two types and have a composite incentive scheme that takes into account the increase in operational efficiency as well as reduction in waste. For example, standard time for operation and a minimum or normal percentage for waste may be fixed. The worker is not entitled to any additional payment for operation above standard efficiency if the minimum percentage of waste is exceeded. If the percentage of waste is below the minimum, bonus both for waste reduction and increased output is paid.

An example to illustrate the method of payment of incentives and imposition of penalty in respect of indirect workers is given below.

EXAMPLE 3.9.

Both direct and indirect labour of a department in a factory are entitled to production bonus in accordance with a Group Incentive Scheme, the outlines of which are as follows :—

(a) For any production in excess of the standard rate fixed at 10,000 tonnes per month (of 25 days) a general incentive of Rs. 10 per tonne is paid in aggregate. The total amount payable to each separate group is determined on the basis of an assumed percentage of such excess production being contributed by it, namely, @70% by direct labour, @ 10% by inspection staff, @ 12% by maintenance staff and @ 8% by supervisory staff.

(b) Moreover, if the excess production is more than 20% above the standard, direct labour also gets a special bonus @ Rs. 5 per tonne for all production in excess of 120% standard.

(c) Inspection staff are penalised @ Rs. 20 per tonne for rejection by customer in excess of 1% of production.

(d) Maintenance staff are also penalised @ Rs. 20 per hour of machine breakdown.

From the following particulars for the month work out the production bonus earned by each group :

Actual working days	20
Production	11,000 Tonnes
Rejection by customer	200 Tonnes
Machine Breakdown	40 Hours

(I. C. W. A., Inter)

ANSWER : Standard production for 20 working days in the month

$$= \frac{10,000}{25} \times 20 = 8,000 \text{ tonnes}$$

Excess production during the month = Actual production minus standard production
 $= 11,000 - 8,000 = 3,000$ tonnes

Excess production above 20% of standard = $3,000 - 20\%$ of $8,000 = 1,400$ tonnes

The production bonus earned will be :

Direct labour

General incentive ($7\% \times 3,000 \times \text{Rs. } 10$)	= Rs. 21,000
Special incentive ($1,400 \times \text{Rs. } 5$)	= Rs. 7,000
Total bonus	= Rs. 28,000

Inspection staff

General incentive ($10\% \times 3,000 \times \text{Rs. } 10$)	= Rs. 3,000
Less Penalty ($200 - 1\% \times 11,000 \times \text{Rs. } 20$)	= Rs. 1,800
Total bonus	= Rs. 1,200

Maintenance staff

General incentive ($12\% \times 3,000 \times \text{Rs. } 10$)	= Rs. 3,600
Less Penalty ($40 \text{ hours} \times \text{Rs. } 20$)	= Rs. 800
Total bonus	= Rs. 2,800

Supervisory staff

General incentive ($8\% \times 3,000 \times \text{Rs. } 10$)	= Rs. 2,400
Total bonus	= Rs. 2,400

Co-Partnership and Profit Sharing Schemes. Profit sharing schemes are not methods of wage payment although the payment may in some cases be linked with production. Under these schemes, the workers are paid in addition to their wages, a share at an agreed rate from out of the profits of the concern. The profit bonus may also be paid in the form of the shares of the undertaking instead of cash as in the case of co-partnership schemes.

Profit sharing schemes have the following *advantages* :—

- (i) They create a feeling of belonging and involvement and contribute to the welfare of the undertaking.
- (ii) The workers take interest in the management, and labour and management relations are improved.
- (iii) These tend to reduce labour turnover.

Profit sharing schemes have the following *shortcomings* :—

- (a) The profit is outside the control of the worker and is not directly related to his efforts.
- (b) Both inefficient and efficient workers get bonus at the same rate. This is usually paid as a percentage of basic wages.
- (c) Apportionment of the profit on suitable basis presents difficulties.
- (d) Payment is made at long intervals, generally once a year. The share received by a worker is usually small.
- (e) While profits are shared, the worker is not called upon to share the losses.
- (f) Once the worker becomes used to receiving the annual share, non-payment in a particular year for some reason gives rise to discontent. Fluctuation of the share from year to year is also not conducive to good labour relations.
- (g) The workers are not convinced about the authenticity of the profit figures and bonus disputes are not uncommon.

Profit sharing and co-partnership schemes should be distinguished. The former relates to the distribution of certain percentage of profit among all workers whereas the latter confers certain shares or partnership benefits for sharing profit or loss.

Supplementary Financial Incentives. So far, incentive plans based on output have been discussed. Incentives supplementary to production and payable in addition to the normal wages, may be given to the employees for various other purposes and in a number of ways. Some of these are mentioned below :

- (a) For *reducing the cost of material* by getting greater yields, reducing waste and spoilage, and economising in the use of auxiliary materials such as fuel, power, steam, compressed air, etc. These methods are used when the cost of material is proportionately high. A normal percentage of waste is fixed for each item of production as a standard per unit and all reductions below the standard are rewarded by a suitable bonus proportionate to the saving effected. The method is similar to the cost efficiency bonus plans.
- (b) For *improving quality*. This is used when the quality of a product is of paramount importance. A high standard for inspection of quality is laid down and a bonus is paid in inverse proportion to the rejections detected in course of inspection.
- (c) For *good maintenance work* so that break-down is reduced.
- (d) For *regular attendance and punctuality (Time-keeping or Attendance bonus)*. This is used for discouraging absenteeism and tardiness and is usually given as a percentage of the basic wages.
- (e) For *safety precautions*. This is used to obviate payment of compensation when the job is of a hazardous nature. The bonus is mostly in the form of a cash reward or prize.
- (f) Prizes and cash awards for *suggestions, technological improvements, etc.*
- (g) Special awards for *long periods of service*.

Non-Monetary Incentives (or Psychological Incentives). These incentives, usually given in the form of amenities or facilities, do not offer cash reward to the employee for any specific or measured work done. Such non-monetary benefits create a psychological effect by making the working conditions and terms of employment lucrative enough to induce the employee to increase his efforts. The benefit goes to all the employees in the undertaking and is not limited to any individual, class, or group. As a result of this and also because there is no immediate return which can be linked with individual effort, the employees take the benefits for granted and the incentive element is lost.

Non-financial benefits may be offered in several ways. A few examples are mentioned below :

- (a) Favourable working conditions
- (b) Medical facilities for the individual and his family
- (c) Educational facilities-
- (d) Welfare measures

- (e) Cheap grains
- (f) Subsidised canteen
- (g) Recreational amenities
- (h) Housing facilities
- (i) Pension schemes
- (j) Fund contributions
- (k) Protective clothing, liveries, uniforms, etc.
- (l) Tea, milk, etc. for specially arduous work.

It will be noted from the above list that some of the benefits offered are obligatory under law or are given as a matter of convention. Such benefits cannot, strictly speaking, be termed as incentives. They are non-financial only so far as the employee is concerned. The employer has to incur expenditure to provide for the incentive.

Non-financial incentives offer the following advantages :--

- (a) Reduce labour turnover.
- (b) Impart satisfaction to the employees and create a sense of loyalty and co-operation in them.
- (c) Reduce absenteeism.
- (d) Create a reputation for the undertaking so that the best labour is attracted.

Payment of Salaries/Compensation to Managerial Personnel. The determination of equitable compensation payable to managerial personnel poses a difficult problem for the management. It is difficult to measure the job worth of such personnel, there are no market rates available as guides since an individual having the same designation as another in a sister concern may have different jobs assigned and be paid different rates of pay, and there is no definite relationship between the pay of a manager and the number of men he supervises. As a result of these problems, pay scales of executives particularly, those holding higher or top positions are usually fixed on more or less arbitrary basis.

The common practice is to compensate the managerial personnel by allowing perquisites or fringe benefits in addition to their salary. Some of these are :

- (i) Bonus on profits. This may be related to the profit of the manager's Division or to the overall profit of the business.
- (ii) Benefits of conveyance, house, electricity etc.
- (iii) Membership of clubs.
- (iv) Rights to buy shares of the company at advantageous price.
- (v) Medical aid.
- (vi) Pension, gratuity and other deferred fringe payments.

It may be noted that some of these fringe benefits are now being made admissible to non-managerial personnel as well but the compensation to managerial personnel would be definitely on a higher scale to take care of additional hours of work put in and the added skill, efficiency and responsibility required by their jobs.

Calculation of Wages and Preparation of Payroll. Calculation of the wages payable to a worker is the responsibility of the Payrolls or Wages Department and the procedures described in these paragraphs devolve on that department. Calculation

of wages is made in payrolls (or Wages or Salaries Sheets). The attendance for the wage period as recorded in the clock cards or other attendance records is transcribed in totals into the payroll. Normal time and overtime attendances are entered in separate columns. Another practice which avoids duplication of work is to extend the columns of the attendance record itself, by adding the necessary columns, so that it serves the purpose of a combined attendance record and payroll.

The payroll shows the names, ticket numbers, trades, grades and rates of pay of the workers, and several other columns are provided for entering the various types of pay and allowances and deductions in respect of each worker (see *insertion*). As in the case of attendance records, separate payrolls are maintained for each department wherein the details are entered in serial order of the ticket numbers of the workers in the department. Separate departmental records showing the wages paid for each department are essential for cost control each department may constitute a cost centre—and for determination of overhead recovery rates. Another advantage is that being smaller in bulk, departmental payrolls are easier to handle.

When a worker is transferred from one department to another in course of a wage-period, his name should find place in the payroll of the department in which he had worked on the last day of the wage-period and the particulars of his attendance etc. in all the other departments where he worked, should be transferred to this payroll. This facilitates calculation of wages and disbursement to the worker. For convenience in wage calculation, the payrolls of workers paid under different systems of wage-payment may be maintained separately.

On completion of the wage period, the work of calculation of wages starts. The Payment of Wages Act stipulates time limits within which payment of wages is required to be made. Calculations of various elements constituting the wages, e.g. basic wages (time-rate pay, piece-work earning and bonus, where admissible), overtime wages and premium, leave pay, holiday pay, and dearness and other allowances are made in respect of each worker and entered against his name in the appropriate columns of the payrolls. Entries in separate columns are necessary not only to enable the worker to know the break up of his wage packet but also because the methods of accounting and control of the various elements would be different. Basic pay and overtime pay, for example, are charged direct to the cost of products or jobs whereas the allowances may be booked to various Standing Order Numbers and debited to overhead.

For ease in calculation and payment and in order to simplify accounting, wages are often rounded off to a specified minimum unit of money. For instance, all fractions of a rupee may be rounded in multiples of ten paise, amounts below five-paise being ignored and five paise and above taken as the next ten paise. Rounding may be done in respect of each element or in the total net wages only.

After calculation of gross wages as stated above, the payrolls are passed on to another clerk who makes the entries for deductions from pay, e.g. fund contributions, house rent, income tax, fine, recoveries for services received, etc., and calculates the net amount of wages payable to each worker. A Pay Slip (Fig. 3.17) showing the broad details of payment due is then made out and handed over to the worker in advance of the actual payment of wages in cash.

PAY SLIP	
Name	
Ticket No.	
Department	
Wage Period	
Basic wages	Rs.
Overtime	Rs.
Dearness allowance	Rs.
Leave Pay	Rs.
Other allowances	Rs.
Gross wages	Rs.
Fund contribution	Rs.
Tax	Rs.
House rent	Rs.
Other deductions	Rs.
Net wages due	Rs.
Signature.	
Date.....	
<ol style="list-style-type: none"> 1. Complaints, if any, should be made on receipt of this slip, in course of the day. 2. When you receive cash, check it up with the net amount shown above. 	

Fig. 3.17. Pay Slip

In some factories, pay slips are not prepared separately. The payroll is prepared in duplicate, the duplicate copy of which is suitably perforated so as to separate the entries relating to each worker. While the original copy serves the purpose of payroll, the duplicate copy is torn off along the perforations and handed over to each worker to serve the purpose of pay slip.

Disbursement of Wages. On completion, the payrolls are sent to the Cash Office for disbursement of wages. Generally workers are not called upon to collect their wages from the cash office and payment is made in the departments or shops in which they are working. This avoids waste of time and stoppage of work and facilitates identification of the workers in their respective shops, so that payment is made only to the right person. The total amount payable is obtained in cash from the bank and the amount due to each worker is counted in exact denominations and put in envelopes (or in packets, small tubes or boxes); one such envelope is allotted to each worker. The envelopes are carried by the cash office staff to the departments and payment is made in the presence of the department's representative or a responsible official who identifies the workers as they come up to collect their envelopes. Practice varies regarding the signing of the payrolls by workers in token of having received payment. Where the workers do not sign the rolls, it is advisable to ask the department's representative to sign each payment entry. Payment for a worker who is absent is not made to any other person unless a signed letter or slip from the absent worker is produced authorising

the nominee to receive payment on his behalf. In case of doubt, payment is made only after proper investigation.

Prevention of Fraud in Wage Payment. From what has been stated above, it will be apparent that an elaborate routine is followed in regard to the booking of attendance, calculation of wages and actual payment to workers. This is essential with a view to eliminating the risk of malpractices and fraud in payment of wages. One of the notorious practices for perpetuating fraud is to claim payment for ghost or dummy workers, i.e. workers who do not exist but whose names are fraudulently entered in the rolls. Payment may also be claimed for time not worked. The types of frauds usually perpetuated are :

- (i) Inclusion of dummy worker in the pay roll.
- (ii) A worker removing another's token or clocking in for another person. (A lower rated worker clocking in for a higher rated worker in lieu of his own).
- (iii) Inclusion of wrong hours.
- (iv) Use of wrong rate of pay in the pay roll.
- (v) Inclusion of bonus not due, or not entitled to or in excess of the amount due.
- (vi) Payment for work not done (when remuneration is on the basis of results).
- (vii) Omission to record deductions, partial or total.
- (viii) Absent on the date of regular payment and claiming fraudulent payment later.

The steps taken and the internal checks provided for prevention of fraud are :

- (i) Where attendance is recorded at the gate as well as in the shop, the gate and shop attendance records should be reconciled.
- (ii) Agreement of attendance time with time booked to jobs should be made where job cards or time sheets are in use. Any difference between the two times would indicate lost time. Attendance of a dummy worker fraudulently marked, may be detected in the process of reconciliation ; there would not be a corresponding job card booking his time unless there is a collusion between the attendance clerk and the section where the dummy worker is said to work.
- (iii) Overtime work should be authorised in advance and no payment for overtime should be made unless a sanction specifying the number of overtime hours is forthcoming. Overtime hours worked should be correctly recorded ; these should not exceed the hours authorised.
- (iv) Similarly, no one should be allowed to leave the factory before the closing time. All short leave should be sanctioned on prescribed forms and noted in the attendance records and reconciled with the time of departure and arrival as per gate passes.
- (v) Payments for idle time, rejected and spoiled production, extra allowance etc. should be made only if properly authorised by the officer competent to do so.
- (vi) Schedules of day-wage rates and piece-work rates should be prepared.

Any alteration to the schedules should be made only if approved by a responsible officer. There should be a system of checking of the rates copied from the schedules on the pay rolls. If mechanical methods of copying such as Bradma machines or photo copying methods like xerox are used, the chances of fraudulent mistakes are largely obviated.

- (vii) Payment for piece-work and other incentives should be made only when the work is certified by the inspector who should initial the records of output.
- (viii) As a basic principle, as many men and as many departments as practicable should be involved in the routine of wage payment. This reduces chances of collusion between dishonest staff members and eliminates the risk of fraud.
- (ix) Calculations made by one clerk should be checked by another. This check may either be full or partial. The duties of calculation and checking should be interchanged and arranged in rotation so that there is no collusion. A test check of the wages sheets should occasionally be carried out by the Personnel Officer or the Works Manager.
- (x) Payrolls should be signed by the individuals who prepare and check them.
- (xi) Only the exact amount required for payment is drawn from the Bank and the exact cash payable to each worker is counted and put into individual envelopes or pay packets.
- (xii) Payment to a worker is made only after proper identification.
- (xiii) Payment of wages should be made on fixed dates only. Unclaimed wages should be disbursed on stipulated dates under strict supervision and after proper scrutiny as to why payment was not claimed on the date fixed for regular payment.
- (xiv) Wages for out-workers or casual workers who work on locations away from the factory or headquarters should be paid by the staff from the Head or Main Cash Office, who should be deputed at site for the purpose. Cash should not normally be remitted for disbursement by local staff.
- (xv) On termination of service or on retirement of a worker, suitable notification to the effect should be promptly circulated to all concerned and payment of wages should be carefully made as any wrong or fraudulent payment once made is difficult to rectify or recover later.

Transfer from one Job to another. It often becomes necessary to transfer a worker from one job to another with the object of restoring the balance of output flow. For remunerating him correctly at his usual rate or at a different rate assigned to the new job, care should be taken in the preparation of the payroll as well as the job card. In the case of a piece-worker being assigned a time-rated job, double payment, i.e. both on time and for the piece work, may be avoided by making proper notes in the attendance records and in the piece-work cards. In addition, a transfer memo is essential.

The job to which a worker is transferred should, as far as practicable, carry

the same rates of pay and responsibilities as his existing work. Though this does not affect a day-worker, he generally resents being given higher responsibilities without any increase in remuneration. In such cases, his day-rate should be made up to the higher rate of the job to which he is transferred. In any case, his wages for the week should not fall below the normal.

The position is different in the case of workers paid on results. Transfer to new jobs results in reduction of productivity as well as loss in earnings for the worker. Being used to his old job in which he has become a sort of an expert, he needs time to pick up the new job. For some time, therefore, his earnings which he got on the previous job may be protected.

Idle Time Cost. Idle time cost represents the wages paid for the time lost during which the worker does not work. This happens because due to various causes for which he is not responsible, the worker remains idle but full wages are paid to him. Even for workers who are paid on the basis of output, idle time payment may be required to be made.

The *causes* leading to idle time may be broadly classified into four categories, viz:

- (i) Time lost between gate and place of work, break for tea, time interval between one job and another, time for tool setting, adjustment of machine, etc.
- (ii) Normal idle time such as waits for jobs, tools, materials, or instructions, power failures, breakdown of machines and tools, and atmospheric conditions
- (iii) Abnormal idle time such as those arising due to breakdown for considerable period, non-availability of raw materials, slack supervision, strikes or lock-outs, fire, flood, storm, etc.
- (iv) Concealed idle time such as manipulation of job booking, wastage of time due to under-employment, i.e. unnecessary work like cleaning, grass cutting, and gardening to employ idle men, and employment of skilled workers on unskilled jobs.

Idle time should not be booked directly to jobs or production orders because such a practice not only increases the cost of direct labour but also vitiates comparison of idle time costs from period to period. In booking time, idle or waiting time should not normally be recorded in the job card but on a separate idle time card as illustrated in Fig. 3.18. Separate cards or registers may be provided for recording idle time according to the causes which give rise to it.

Idle time falling under category (i) above would be for insignificant periods. In cost accounts, this is treated by neglect, i.e. the idle time is allowed to remain merged in the Production Order or Standing Order Number on which the worker was otherwise employed.

Normal idle time is booked to factory or works overhead. For the purpose of effective control, each type of idle time, i.e. idle time classified according to the causes is allotted a separate Standing Order Number.

Abnormal idle time would usually be heavy in amount involving longer

periods and would mostly be beyond the control of the management. Payment for such idle time is not included in costs and is adjusted through the Costing Profit and Loss Account or included in Profit and Loss account, when accounts are integrated.

Tendency to conceal idle time should be discouraged. Idle time involves not only infructuous payment of wages for non-effective time and the resultant loss of profit due to reduced production activity but it also increases the cost

IDLE TIME CARD						
Name			Department			
Ticket No.			Date			
Reason for idle time	Standing Order No.	Time			Cost	
		From	To	Period	Rate	Amount
Power failure						
Breakdown						
Waiting for .						
Job Instruction						
Tools, material etc.						
Atmospheric condition						
Other causes						

Fig. 3.18. Idle Time Card

per unit of production as the fixed costs continue to be incurred, irrespective of the reduced quantum of production due to loss of labour time. Idle time should, therefore, be highlighted prominently so that action can be taken to remove the causes thereof. Although for obvious reasons, it is not possible to record minor details, vigilance is necessary for finding out long-term idleness amongst the workers.

Idle time may be eliminated or reduced to a large extent by taking suitable preventive measures such as (i) proper planning of production in advance, thus reducing imbalances in production facilities, (ii) timely provisioning of materials, (iii) regular maintenance of machines so as to avoid breakdown, and (iv) careful watch over the labour utilization statement (See Fig 3.19). The remedial measure to be taken will, no doubt, depend on the particular factor or situation which caused the idle time.

LABOUR UTILIZATION STATEMENT

Period.....			Department							
Ticket No.	Attendance hours	Hours booked to jobs	Idle time hours analysis						Actual standard hours produced	Efficiency ratio
			Idle time hours (total)	No job	No material	No machine	Load shedding	Other causes		
241	200	200	—	—	—	—	—	—	210	$\frac{210}{200} = 105\%$
243	200	190	10	5	—	—	5	—	100	$\frac{100}{190} = 50\%$
244	180	150	30	—	—	—	20	10	60	$\frac{60}{150} = 33\frac{1}{3}\%$
248	200	200	—	—	—	—	—	—	150	$\frac{150}{200} = 75\%$
249	200	180	20	—	10	10	—	—	90	$\frac{90}{180} = 45\%$

Fig. 3.19. Labour utilization statement

Overtime Wages. The Factories Act provides for payment of overtime wages at double the usual rates of wages. Even where the Act is not applicable, the practice is to pay for overtime work at higher rates usually in accordance with a standing agreement between the employer and the workers. Hence, payment of overtime consists of two elements, viz. the normal (i.e. usual) amount, and the extra payment, i.e. the premium. The normal payment is allocated to the Production Order, Standing Order Number, or cost unit on which the worker is employed. The amount of premium is booked to overhead unless overtime is ordered specially for a job, e.g. when desired by a customer and chargeable to him, in which case it is booked to that job. Cost of overtime worked for a capital order, project or contract is allocated to the cost of the capital order, project or contract concerned. If overtime is required to cope with the general production programme or for meeting urgent orders, the amount should be treated as overhead costs of the particular department or cost centre which works overtime. If overtime is worked in a department due to the fault of another department, the overtime premium should be charged to the latter department. When overtime is worked due to seasonal pressure, the overtime wages should be taken either as general overhead or as deferred expenses for absorption equitably over the production of the entire business cycle. Overtime worked on account of abnormal conditions such as flood, earth-quake, etc. should not be charged to cost, but to Costing Profit and Loss Account or Profit and Loss Account if integrated accounts are maintained.

It will thus be seen that overtime involves payment of increased wages and should be resorted to only when extremely essential. The disadvantages attached to overtime working are as follows :—

- (i) It involves excess labour cost.

- (ii) There is decrease in productivity. Output is usually not proportionate to the excess time worked as efficiency during late hours is diminished.
- (iii) Work in the evenings increases lighting cost.
- (iv) Continuous work for long periods leads to fatigue and defective output.
- (v) It tells upon the health of the workers.
- (vi) Overtime work if not properly distributed among the workers may lead to discontent.
- (vii) There is an unusual strain on plant and machinery.
- (viii) Once overtime is resorted to for some time, the workers take the overtime wages as a part of their normal earnings and resist future attempts to discontinue overtime work.
- (ix) There is a tendency to keep work pending to be done during overtime period or to intentionally slow down in order to compel the management to sanction overtime.

It may, however, be said in favour of overtime work that it increases the productive capacity of the concern as more work is done with the existing resources. Overtime work is particularly useful in pulling up backlog in production arising due to shutdown, breakdown, power failure and such other contingencies.

Though overtime work cannot be completely eliminated, it is essential that proper control should be exercised to keep it to the minimum. The following steps should be taken :—

- (i) All overtime work should be duly authorised after investigating the necessity thereof.
- (ii) Booking of overtime hours should follow the same routine as for the booking of normal attendance.
- (iii) Overtime cost should be recorded separately and shown against the department incurring it. This will enable proper investigation and planning of production in future.
- (iv) Productivity during overtime hours is likely to fall. This should be measured and compared with the productivity during normal hours.
- (v) If overtime tends to be a permanent feature, the necessity for recruiting more men and shift working should be considered.
- (vi) If overtime is due to lack of plant and machinery or other resources, steps may be taken to install more machines, etc. or to give sub-contracts or alternatively, to restrict production so as to complete it within the normal time.

Accounting of Labour Costs. Labour time records, viz. time tickets or job cards form the basis and constitute the primary documents for booking time for each cost unit or cost centre and when priced, these indicate the cost against Jobs or Production Orders or Standing Order Numbers, as the case may be. Valuation of the time tickets is done on the basis of the current hourly rates of the individual

workers. Another method is to adopt average hourly rates when a group or a number of employees work interchangeably on similar operations. In this method, an average hourly wage rate of all such workers or of the group is computed and the hours in the time tickets are costed with this rate without reference to the hourly rates of the particular workers who actually perform the work. A third method which is applicable where a worker runs several automatic machines is known as the *Factor Hours* method. Each machine is known as a "factor", and the hours for which it runs is referred to as 'factor hours'. Under this method, a standard factor-hour cost is worked out as illustrated below :

Worker's wage rate	Rs. 3 per day
Workings hours per day	8
Machine or 'factors' handled	3
Factor hours per day (3 × 8)	24
Standard cost per factor hour	$-\frac{\text{Rs. } 3}{24} = \text{Re } 0.125$

The machine hours on the time tickets will be costed at the standard rate of Re. 0.125 per hour. The cost of idle machines may also be obtained by valuing the idle machine hours at this rate. Thus, if a particular machine works for only 5 hours on a day :

Labour cost	$= 5 \times \text{Re. } 0.125 = \text{Re. } 0.625$
Idle time cost	$= 3 \times \text{Re. } 0.125 = \text{Re. } 0.375$

Labour time records are arranged in the under-mentioned three ways :

- (i) *According to each worker* : This is necessary for the payment of wages to workers. As stated earlier, the attendance time is reconciled with the job time in all cases whether payment is made under the time-rate, piece-work, or any other system. For the time workers, the wages payable are calculated from the attendance time records. In case of piece-worker, the quantity of work done by a worker as recorded in piece-work cards is priced with reference to the piece-rates. The total value of the piece-work cards pertaining to a worker for a wage period, is his piece-work earning. Similarly, in other systems of payment, the wages due are calculated on the basis of the attendance cards and/or the time cards. The amount of wages due to a worker as calculated above, is then transferred to the payroll or wages sheets.
- (ii) *According to each cost centre and/or cost unit* : When payrolls or wages sheets are maintained separately for each department or cost centre, the total of each payroll, after posting the wages in respect of each worker employed in the cost centre as stated under (i) above, indicates the labour cost for that cost centre. In case of process costing, where a cost centre is synonymous with a process, the total of the payroll for that cost centre constitutes the labour cost of the process for the accounting period and no further analysis is necessary.

account, i.e. Work-in-progress (for direct orders including capital jobs), Factory Administration, and Selling and Distribution Overhead Control Accounts. If a voucher register is maintained, this information will be available in that register. The ruling for a Wages Analysis Book, is illustrated in Fig. 3.21.

- (iii) *According to each machine :* Where machine labour is predominant, this analysis is useful for finding out whether machine time has been properly utilized. The machine time cards pertaining to a machine show the effective time of the machine which is compared with its rated or budgeted running time. Any difference between the two would indicate idle machine hours in the same manner as reconciliation between gate time and job time for each worker reveals idle man hours. A machine utilization statement showing the budgeted and standard hours and the actual hours worked is illustrated in Fig. 3.22

WAGES ANALYSIS						
			Period			
Department	Total Wages	Work-in-Progress Account	Factory Overhead Control Account	Administration Overhead Control Account	Selling & Distribution Overhead Control Account	Deductions Fund Tax, Other deductions
Total						

Fig 3.21 Summary of Wages or Wages Analysis Book

Note The costs relating to Capital and Research Orders are initially booked to Work-in-Progress Account and subsequently transferred at the end of the accounting period to Capital Order and Research Order Accounts by contra-credit to Work-in-Progress Account. In case the practice is to book the costs direct to Capital Order and Research Order Accounts, separate columns for these accounts should be provided in the form

Summary of Accounting Procedure. A flow chart summarising the accounting procedure described above is given in Fig. 3.23. This may be compared with the material accounting flow chart given in Fig. 2.25. The journal entries in the cost books for the accounting of labour cost may be seen in Chapter 6.

MACHINE UTILIZATION STATEMENT															
Department..... Foreman 1.....										Week ending.....					
Machine No.	Particulars	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Idle Hours Analysis						
									A	B	C	D	E	F	G
	Maximum hours available per week	(3)	(4)	Actual hours of work available	Actual hours worked	Standard hours allowed for actual work	" Efficiency of work (Standard hours 100) Actual hours	Idle hours = (5) - (6)	Preparation time	Machine breakdown	Lack of material	Lack of operative	Lack of tools	Lack of instructions	Other causes
1		45	45	45	40	50	125	5	2	—	2	1	—	—	—
2		45	40	40	35	35	100	5	1	—	—	—	2	—	2
3		45	30	40	36	45	125	4	—	4	—	—	—	—	—
4		40	10	10	10	10	100	—	—	—	—	—	—	—	—
5		45	40	40	22	33	150	18	5	13	—	—	—	—	—

Fig. 3.22. Machine Utilization Statement

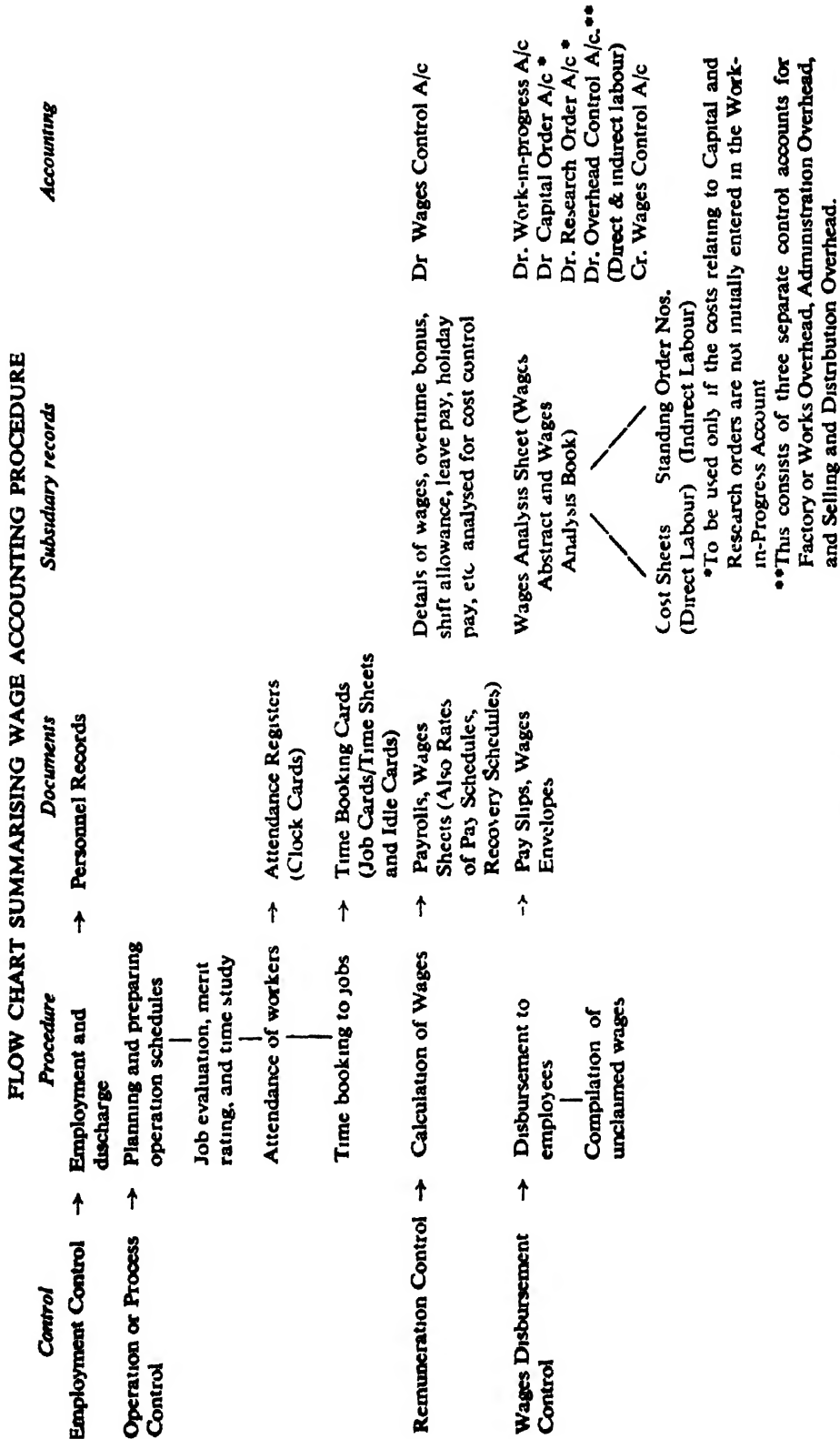


Fig. 121 Wage Accounting Procedure

Labour Turnover. In every business organisation, occasions arise when some one or the other of its employees would be quitting employment. On the other hand, new men would be recruited to fill in the gaps so created. This process of leaving and coming in of the employees is thus a normal feature that we come across in any concern. Labour turnover of an organisation is this change in the labour force during a specified period measured against a suitable index. For this purpose, the standard or usual labour turnover in the industry or locality, or the labour turnover rate for a past period may be taken as the index or norm. The rate of labour turnover in an industry depends upon several factors such as, nature of the industry, its size, location, and composition of the labour force. Labour turnover arising out of discharges due to normal causes like deaths, retirement and superannuation and the consequential engagement is inevitable, the quantum of which will also be generally low. Such normal labour turnover does not present any particular problem. Increase in the labour force due to recruitment to meet the needs of expanding activities of the concern, the expenditure on which should legitimately be a charge to expansion costs, and decrease due to discharge of temporary workers after completion of a project should not be taken into account in the computation of labour turnover index. When the turnover shows an increasing trend as compared between one period and another or between several firms in the same industry, without any long term increase in the productive capacity of the concern, an investigation into the causes should be made. At the same time, abnormally low labour turnover indicates absence of the required flexibility which calls for corrective action to put it at par with those of other firms in the industry. A very low labour turnover may also be due to the existence of inefficient workers who would not like to leave whatever be the provocation. A controlled level of labour turnover is, therefore, considered desirable because it helps the firm to adjust the size of its labour force in response to needs, such as for seasonal changes or changes in technology.

Increasing labour turnover is a double edged malady : it reduces the productivity of labour and results in high costs. The cost of labour turnover may be analysed under two broad headings, viz. preventive costs and replacement costs. Preventive costs refer to all those items of expenditure which are incurred in order to keep the workers satisfied and thus to act as discouragement against leaving employment. Replacement costs are those costs which are incurred for the recruitment and training of new hands and the resulting losses, wastages and lowering of productivity due to the inexperience and inefficiency of the new labour force. While preventive costs may be booked to general overheads (say, under welfare measures), replacement cost are usually booked to the shops or departments concerned.

Preventive costs may be further grouped under the following heads :—

- (i) *Personnel administration* : Most concerns would have a Personnel Department which is entrusted with recruitment, training, and other problems arising out of the employment of the labour force. Obviously, the entire expenditure of the department cannot be treated as labour turnover costs but a portion of the costs which relates to the efforts of the Personnel Manager in maintaining good relationship between the management and the staff should be treated as preventive

labour turnover cost. The labour force remains satisfied if properly looked after and if grievances are sympathetically considered.

- (ii) *Medical service (preventive and curative)* : Care for own health and that of the family members gets prior consideration with the workers who prefer those concerns where medical services are available. Further, a healthy worker is an asset to a firm as he is able to make substantial contribution towards higher efficiency and productivity.
- (iii) *Welfare activities and schemes* : These include facilities like subsidised canteens, co-operative store, laundry and washing services, sports, housing schemes, transport, and educational facilities. These facilities are as good as higher wages offering incentive to the worker to stay with the firm.
- (iv) *Miscellaneous schemes such as pension or provident fund schemes, bonus, high wage plans and other incentive schemes* : Greater the advantages these perquisites offer, the lower will be the rate of labour turnover.

Replacement costs consist of the following

- (i) *Loss of output due to delay in obtaining new workers* : As suitable workers may not be available readily, there is a time gap before a new worker can replace the old one. During this period some output may be maintained by retaining surplus nucleus labour force to meet such contingencies or by working overtime. All such extra costs should be taken as labour turnover cost.
- (ii) *Employment Department expenses* : With the increase in the tempo of recruitment, additional work is thrown on the Employment or Personnel Department. Administrative expenditure is incurred for the selection, test, and medical examination of the new hands, and for writing initial documents like service records, fund accounts etc. after the appointment of a worker has been approved. The cost of the employment department, therefore, varies in sympathy with the rate of labour turnover. Recruitment may sometimes have to be made in unfavourable conditions because suitable men may not be always available in the labour market or if available, they can be attracted only by special inducements in the form of increased pay and fringe benefits. The cost of recruitment may to some extent be reduced by keeping a panel of selected candidates, future appointments may be made from the panel.
- (iii) *Induction training for new workers* : Unless skilled workers are recruited (more likely on higher rates of pay) who can be straightway put on jobs, the average worker has to be given some induction training before he is fit to be put on his assigned work. For certain categories of skilled and highly skilled jobs, intensive training for some period may be essential. The initial period of training is mostly unproductive and it is only towards the later period of the training that the worker does some productive work. The increase in costs is two fold, viz. the expenditure on training and the cost of productive

time lost. The cost of training may be minimised by installing an efficient training scheme. Visual and audio-aids like films, slides and tape recorders help in speeding up the process of training.

- (iv) *Inefficiency of new workers* : The efficiency of new hands being generally low, productivity is reduced and cost increases.
- (v) *Cost of tool and machine breakages* : While on training and during the initial stages of work after completion of training, the worker is likely to break tools more frequently on account of his inexperience. Due to faulty handling, machine breakdown may also occur very often. The cost is ascertained by booking expenditure under relevant Standing Order Numbers. Breakdown in one department may create a bottle-neck and hamper work in the other departments. The cost of such losses of output would form a part of labour turnover cost.
- (vi) *Cost of scrap and defective work* : A new worker is likely to spoil work and although in most cases responsibility can be fixed on him and no wages paid for the scrapped work, the expenditure incurred on material and wages for the earlier operations done on the job becomes infructuous. To this, the costs of loss of production, upsetting of schedules etc. have to be added. Difficulty, however, arises in assessing the cost of scrap and defective work as old hands too are liable to turn out defective work and also break tools and machines in the processes. In such cases, a suitable norm may be set for breakage and defective work ; excess over the norm may be attributed to the new hands.
- (vii) *Cost of accidents* : On account of his inexperience, the new worker is apt to disregard safety rules and he is thus more prone to accidents. The costs include cost of output lost, expenditure on loss of time and compensation for the injured worker, damage of material and equipment accompanying injury, time lost by the supervisory staff and others in assisting the injured worker and making out reports etc. and impact on morale due to too frequent accidents.

It may be noted that the increases in labour costs due to high labour turnover contribute to create an inflationary trend in the industry.

While the costs directly attributable to labour turnover may be easily found out, some analysis is necessary for computing other costs consequent to loss of production. The calculation of the latter costs is illustrated below .

EXAMPLE 3 10.

The position at the end of a year in respect of a company was as follows :—

		Rs. (lakh)
Sales		10
Variable Cost :		
Direct material	Rs. 2.5 lakh	
Direct labour	Rs. 2.0 lakh	
Variable overhead	Rs. 2.0 lakh	
Marginal contribution		<u>6.5</u>
Fixed cost		1.5
Profit		<u>Rs. 2.0</u>

On an analysis of the above position it was found that there had been a drop in the profit due to labour turnover. It was seen that the direct labour hours worked were 1,01,000 hours as follows :

Permanent workers	99,000
Trainees	2,000
	<hr/>
	1,01,000 hours

Only half of the direct labour hours put in by the trainees were productive. Due to delay in replacing the workers who had left during the year, 4,000 direct labour hours were lost.

You are required to calculate the profit lost on account of loss of production due to labour turnover.

ANSWER :

Effective direct labour hours :

Permanent workers	99,000
Trainees ($\frac{1}{2}$ of 2,000 hrs.)	1,000
	<hr/>
Total	1,00,000 hours

Sales per direct labour hour = Rs. 10,00,000/1,00,000 = Rs. 10

Loss of productive hours :

For replacement	4,000
For trainees	1,000
	<hr/>
	5,000 hours

Loss of potential sales = 5,000 \times Rs. 10 = Rs. 50,000

(Assuming that there would have been no change in sales price)

But for the labour turnover, the sales would have been Rs. 10,00,000 + Rs. 50,000

Rs. 10,50,000

The costs incurred for the extra Rs. 0.50 Lakh sales lost would have been (assuming no change in efficiency) :

Direct labour for 4,000 hours lost	$\frac{\text{Rs. 2 lakh}}{1,01,000} \times 4,000$	Rs. 7,920 (rounded off)
Material and variable overhead for extra Rs. 0.50 lakh sales	$\frac{\text{Rs. 4.5 lakh}}{\text{Rs. 10 lakh}} \times \text{Rs. 0.5 lakh}$	= Rs. 22,500

Potential profit with no labour turnover :

Sales		Rs. 10,50,000
Variable cost :		
Direct labour	Rs. 2,00,000	
	+ 7,920	
Direct material and variable overhead	Rs. 4,50,000	
	+ 22,500	
	<hr/>	6,80,420
Contribution margin		<hr/> 3,69,580
Fixed cost		1,50,000
		<hr/>
Potential profit		2,19,580
Current actual profit		2,00,000
		<hr/>
Loss of profit due to labour turnover		Rs. 19,580

Causes of labour turnover. The causes giving rise to high labour turnover may be broadly classified under the following three heads :—

A. Personal causes : Workers may leave employment purely on personal grounds, e.g.

- (a) Dislike for the job, locality, or environments.
- (b) Domestic troubles and family responsibilities.
- (c) Change of line for betterment.
- (d) Retirement due to old age and ill health.
- (e) Death.

In all such cases, personal factors count the most and the employer can practically do nothing to help the situation.

B. Unavoidable causes : In certain circumstances it becomes obligatory on the part of the management to ask some of the workers to leave. These circumstances are :

- (a) Retrenchment due to seasonal trade, shortage of material and other resources, slack market for the product, etc.
- (b) Discharge on disciplinary grounds.
- (c) Discharge due to continued or long absence.

C. Avoidable causes : Under this head, may be grouped the causes which need the attention of the management most so that the turnover may be kept low by taking remedial measures. The main reasons for which workers leave are :

- (a) Unsuitability of job.
- (b) Low pay and allowances.
- (c) Unsatisfactory working conditions.
- (d) Unhappy relations with co-workers and unsatisfactory behaviour of superiors.
- (e) Disputes between rival trade unions.
- (f) Lack of transport, accommodation, medical and other facilities.
- (g) Lack of amenities like recreational centres, schools etc.

The above causes may also be classified in a different manner under three heads, viz. financial causes, social and economic causes, and psychological causes relating to human relationship.

Measurement of Labour Turnover. The various formulae for determining labour turnover are given below. While the base or the denominator is almost always the average number of employees on roll during the period under consideration, the change in labour force is indicated, either by the number of employees replaced (or to be replaced) or employees left (i.e. separated), or employees joining as well as leaving. The average number of employees is usually taken as the simple average of the numbers at the beginning and at the end of the stipulated period.

$$\text{Labour turnover} = \frac{\text{Number of employees replaced}}{\text{Average number of employees on roll}} \quad \text{(i) Net rate or Replacement rate}$$

or

$$= \frac{\text{Number of employees left}}{\text{Average number of employees on roll}} \quad \text{(ii) Separation rate}$$

or
$$\frac{\text{Number joining plus number leaving}}{\text{Average number on roll}} \quad \text{(iii) Flux rate}$$

Average number of employees (Number at beginning plus number at end)/2

The turnover may be expressed either as a fraction or as a percentage. The analysis may be made separately for each department or for the factory as a whole. Labour turnover index may also be calculated in accordance with the following :—

- (i) By age groups
- (ii) By length of service groups. known as the stability index, this measures the stability of labour. The index in respect of senior and experienced group of workers needs to be more carefully watched and controlled.
- (iii) By sex

LABOUR TURNOVER REPORT			
Department . Tool Room	Month March 1987		
	Current month	Last month	Corresponding month last year
Number of employees on first day of month	60	62	70
Number of employees on last day of month	50	60	80
Average labour force	55	61	75
Number left during month	8	6	10
Number recruited during month	7	4	10
Flux rate (%)	27.27	16.39	26.67
Analysis of number left			
(a) <i>Personal Causes</i>			
Retirement	1	1	
Change for betterment	1	2	6
Dislike of job		1	
Other reasons		2	4
(b) <i>Unavoidable Causes</i>			
Retrenchment			
Disciplinary grounds			
Other causes			
(c) <i>Avoidable Causes</i>			
Lower pay	2		
Dispute between Labour Unions	4		
Unsatisfactory working conditions			
Lack of amenities			
Other reasons			

Fig 3.24 Labour Turnover Report

- (iv) By trades, e.g. mechanic, carpenter, fitter, etc.
- (v) By grades, e.g. skilled, semi-skilled, and unskilled.
- (vi) By methods of payment, e.g. time workers, piece-workers, etc.

A labour turnover report is illustrated in Fig. 3.24.

Reduction of labour turnover. Labour turnover may be reduced by removing its avoidable causes (Page 173) and taking preventive remedial measures (Page 169). The various measures may be summarised as follows :-

- (i) Efficient, sympathetic and impartial personnel administration.
- (ii) Effective communication system so that workers are kept suitably informed on matters that affect them.
- (iii) Improving working conditions and placing the right man on the right job.
- (iv) Job enrichment to reduce boredom and monotony and to provide job satisfaction.
- (v) Introducing fair rates of pay and allowances and incentives, pensions, gratuity etc.
- (vi) Strengthening welfare measures.
- (vii) Augmenting recreational activities and schemes.

EXAMINATION QUESTIONS

1. Design an employee record card containing all relevant informations for use by both the wages and personnel offices (I. C. M. A., Pt II)
2. Design a personnel record form for use by the wages office to contain all control information for wage entitlements and personnel analysis. (I. C. M. A., Pt II)
3. In a factory men are employed partly indoors and partly outdoors. Give a method which will ensure correct accounting of their time. (I. C. W. A., Inter)
4. Discuss the main purposes of time-keeping at the entrance of the factory and time booking at the department under three headings ; (a) for payment of wages, (b) for cost ascertainment and estimating and (c) for other reasons. (I. C. M. A., Inter)
5. What is the difference between an Attendance Time Card and Job Time Card ? Give specimen forms and illustrate your answer. (I. C. W. A., Inter)
6. The management of a company gets information that some workers are checking the time cards of fellow workers who are absent. Suggest measures that shall be adopted to prevent overpayment of wages to such absentees. (I. C. W. A., Inter)
7. What are the advantages and disadvantages of the following methods of recording labour :
 (a) daily time sheets,
 (b) weekly time sheets,
 (c) job cards accompanying each job through the works ? (I. C. W. A., Inter)
8. A company recently purchased a running factory engaged on similar products. Time booking system of that factory is not the same. In own factory, each operative books time to each job in the weekly cards whereas in the new factory, each operative books his time in the card issued with the work which accompanies it throughout its progress. Discuss with reasons which system you will prefer. To effect uniform costing how would you change the procedure ? (I. C. W. A., Inter)
9. Design a combined clock and job card which will provide information for both pay and costing purposes. (I. C. M. A., Pt. II)
10. Your directors have set up a factory work-study department, whose programme is, in each department, a detailed methods study and methods improvement, followed by work-measurement and the introduction of incentives. You are called upon as Cost Accountant to report independently upon the overall

effect of each department's study. Present a *pro-forma* statement with sample figures such as you might render to your directors. (I C. M. A., Final)

11. What is job evaluation? What functions other than those directly related to wages does such a scheme perform? Briefly outline the job classification method of job evaluation (I. C. M. A., Inter)
12. Give a definition of job evaluation. Tabulate and describe briefly each of the main stages necessary for the construction of a job evaluation table. (I. C. M. A., Pt. II)
13. It is proposed to use job evaluation as the basis of the wages structure in a large firm. Give six factors which might be taken into account in such job evaluation with a brief indication of the meaning of each factor. (I C. M. A., Inter)
14. Specify and write a brief note on each of five main methods of employee remuneration (I. C. M. A., Pt. II)
15. (a) What are the two basic principles of labour remuneration? Show how one of them views the matter from the standpoint of the workman and the other from that of the employer
(b) What is meant by 'Efficiency of labour'? Explain why it has a very important bearing on the cost of production? (M. Com., C U)
16. (a) What do you understand by 'payment by results'? Explain three different types of payment by results commonly in use.
(b) Allowed time for a job was fixed as one hour applying the principles of Time and Motion Study but the job was completed in 40 minutes. Calculate wages under the three methods of payment by results and show cost per article, assuming basic time-rate of 50 paise per hour. (I. C. W. A., Inter)
17. There are four classes of individual systems of payment by results :
(1) Systems with earnings varying in same proportion as output
(2) Systems with earnings varying proportionately less than output.
(3) Systems with earnings varying proportionately more than output
(4) Systems with earnings varying in proportions which differ at different levels of output
State the advantages and disadvantages of each class of system. (I C W A., Management Accountancy)
18. In an engineering works employing expensive machinery, machine operators are paid on a piece-rate basis. Machine efficiency in several sections of the works is low but the production manager does not think this needs corrective action as operators are paid on their production. Do you agree with the production manager? Give reasons for your answer (I C W A., Final)
19. What is the principal justification of incentive schemes in current Indian conditions? Describe the essential features of a successful incentive scheme with which you are familiar or suggest a suitable scheme for an industry which you have studied. (I C. W. A., Inter)
20. What are the steps to be taken for introducing straight piece-rate wages system in a production factory which is not satisfied with the existing day-rate wages system? Discuss its merits and demerits. (I C W A., Inter)
21. Tabulate the advantages and disadvantages of payment by piece work. (I. C. W. A., Inter)
22. State the essential features of the Taylor system of payment of wages by results. (I. C. W. A., Inter)
23. Describe briefly, with an illustration, any one system of payments by results where worker's earnings vary proportionately less than output. Discuss the circumstances where the particular system will be useful. (I. C. W. A., Inter)
24. The time allowed for a job is 8 hours. The hourly labour rate is Re. 1. Prepare a statement, showing the bonus earned, the total earning for labour cost and hourly

- earnings under the Halsey Weir system and Rowan system of premium bonus for each hour saved progressively. Give your comments on the comparative findings in the two systems. *(I. C. W. A., Inter)*
25. Under the Rowan Premium Bonus system, a less efficient worker can obtain the same bonus as a high efficient worker. Discuss. *(I. C. W. A., Inter)*
26. Under what circumstances would you advocate the employment of a group incentive scheme? *(I. C. W. A., Inter)*
27. Western Manufacturers Ltd. manufacturing various engineering goods in a sequence of operations on a conveyor belt system want to introduce a suitable system of labour remuneration as an incentive scheme in place of a flat time-rate system. Write a report, as a Cost Accountant of the firm, outlining the general principles governing any incentive scheme and describing a broad outline of a suitable system. *(I. C. W. A., Inter)*
28. Outline an incentive scheme suitable for indirect labour. How would a shop foreman control this labour in proportion to changes in production volume? *(I. C. M. A., Inter)*
29. What do you understand by the cost efficiency bonus plan? Give a simple illustration of such a plan. *(I. C. M. A., Inter)*
30. What are the advantages to be derived from a bonus system for indirect workers? Discuss the application of such systems and state the alternative basis of which the bonus might be determined. *(I. C. M. A., Inter)*
31. (a) In a capital-intensive process industry, production workers are paid on some form of incentive basis. The management desire to introduce incentive for maintenance workers. Suggest a suitable incentive plan with the basis for incentives.
- (b) In a shoe factory, there is a system of bonus for increased output from the cutters. It has been suggested that there should be an additional bonus for reduction of wasted leather and that this should be on a relatively greater scale. Examine this suggestion and offer your comments. *(I. C. W. A., Final)*
32. In some industries the conditions of working require that employees move from one department to another as production demands. In some cases this may happen several times a day. What means would you advocate for recording and evaluating time spent so that correct charging may be made to each department? Sketch the basic document required for your method. *(I. C. W. A., Inter)*
33. Give a wages sheet ruling for a small company to incorporate both wages and cost accounting. Make several specimen entries to illustrate its working, and give brief note of the source of each entry. *(I. C. M. A., Pt II)*
34. As Cost Accountant in a new factory employing 5,000 employees, you are asked by the General Manager to introduce a good system of recording attendance and payment of wages to workers. Describe clearly the procedures you will adopt and indicate how you would prevent payment to "dummy" workers and other possibilities of fraud. *(I. C. W. A., Inter)*
35. What internal checks would you suggest for averting frauds in the time recording, and preparation and payment of wages? *(I. C. W. A., Inter)*
36. You have been asked by the management to examine the monthly wages bill of their factory since they have reasons to believe that the bill has been inflated. Describe the steps you would take for your checking and the suggestions you would give to the management based on your findings. *(I. C. W. A., Inter)*
37. The following types of errors were detected while scrutinising job cost sheets :—
- (a) Use of wrong hourly rates.
- (b) Labour classified as 'direct' in the cost sheets has been treated as indirect in wages analysis.
- (c) Inclusion of idle time in direct labour.
- What procedure would you introduce in the cost accounting routine to prevent errors? *(I. C. W. A., Inter)*

38. It is frequently necessary to transfer a worker from one job to another with the object of restoring the balance of output flow. Discuss the effect of such transfers on the worker's earnings and schedule the payment conditions which you would advocate for such transfers under time rate and payment by results.
(I. C. M. A., Inter)
39. What are the reasons for booking workers on idle time in a factory? How is idle time controlled? How is idle time treated in cost account?
(I. C. W. A., Inter)
40. What factors can be grouped under the category of idle time and how can they be controlled?
(I. C. W. A., Inter)
41. Tabulate the documentation required for wages accounting? State briefly the purpose of each. Mention the accounting entries in a system of internal accounts.
(I. C. W. A., Inter)
42. For costing purpose, the hours booked in job cards are valued at estimated labour rates for each category of workers. The total labour costs as per job cards do not agree with actual payments as shown in the payroll due to the difference in rates of wages paid to the same category of workers. Comment on this procedure and suggest any internal checks which you would like to introduce.
(I. C. W. A., Inter)
43. In a factory, labour costs are merely worked out as rate per unit of the finished product. In order to help the performance review of each department it has been decided to distribute the labour cost to the various products or processes. Outline the steps you would take as a Cost Accountant for introducing a proper system of distribution of labour costs to various products and processes.
(I. C. W. A., Inter)
44. (a) What do you understand by the term "Wages abstract"?
(b) In a jobbing factory the production labour hours are booked to the jobs cost centrewise. Draw up a proforma wages abstract for a cost centre.
(c) What is the relationship between the hours booked to the jobs and the attendance hours for which wages are paid?
(I. C. W. A., Inter)
45. What is Labour Turnover? Describe the effects of high labour turnover on costs. What conclusions would you draw if labour turnover is abnormally low?
(I. C. W. A., Inter)
46. From the following details calculate for bonus entitlement, the standard time per unit article with a provision of efficiency margin at 60% and 5% of defectives.

	For batch of 400 units mts.	For a trial run of 180 units mts.
Reading drawing etc.	4.5	—
Obtaining tools	6.0	—
Tool fixing	16.5	—
Feeding material for 45 nos.	—	3.5 (Each time)
Setting time for jig etc.	45.0	—
1st Operation	—	145.0
2nd Operation	—	112.5
Removing the setting	15.0	—
3rd Operation	—	188.5

(I. C. W. A., Inter)

47. Calculate total monthly remuneration of three workers A, B and C from the following data :
- (a) Standard production per month per worker—1,000 units
Actual production during month :
A—850 units
B—750 units
C—950 units
- (b) Piece-work rate 10P per unit (actual production).

(c) Additional production bonus is Rs. 10 for each percentage of actual production exceeding 80% actual production over standard (examples : 80%—nil, 81%—Rs. 10, 82%—Rs. 20 and so on.)

(d) Dearness pay fixed : Rs. 50 per month. (I. C. W. A., Inter)

48. What will be the earning of a worker at Re. 0.55 per hour when he takes 140 hours to do a volume of work for which the standard time allowed is 200 hours. The plan of payment of bonus is on a sliding scale as under :

Within the first 10% of saving in standard time, bonus is	40% of time saved
Within the second 10% of saving in standard time, bonus is	50% of time saved
Within the third 10% of saving in standard time, bonus is	60% of time saved
Within the fourth 10% of saving in standard time, bonus is	70% of time saved
For the rest	75% of time saved

(I. C. W. A., Inter)

49. According to a suggestion box scheme, an award equivalent to six month's saving in labour cost is granted to employees whose suggestions are accepted. Suggestion of an employee to use a jig for a manufacturing operation of a component has been accepted as it is found that the cost of jig is only Rs. 600 (life one year) and that the standard time can be reduced by three minutes.

Compute from the following data,

- (a) the amount of the award,
- (b) the estimated saving to the company per year,
- (c) the revised estimated cost of the component.
 - (i) Number of pieces to be produced in one year — 12,000
 - (ii) Standard time per piece before use of jig — One hour
 - (iii) Raw materials required per piece — 10 kgs. @ Re. 0.75 per kg.
 - (iv) Average rate of workmen — Rs. 6 per day of 8 hours
 - (v) Average efficiency of workmen — 75%

$$(\text{Efficiency} = \frac{\text{Standard time}}{\text{Actual time}} \times 100)$$

- (vi) Overhead charge — Rs. 6 per actual hour
- (vii) Store handling expenses — 2% of value of direct materials.

(I. C. W. A., Inter)

50. In a factory bonus system, bonus hours are credited to the employees in the proportion of time taken which time saved bears to time allowed. Jobs are carried forward from one week to another. No overtime is worked and payment is made in full for all units worked on, including those subsequently rejected. From the following information you are required to calculate for each employee :

- (a) the bonus hours and amount of bonus earned ;
- (b) the total wage costs ;
- (c) the wage cost of each good unit produced.

Employee	.. A	B	C
Basic-wage rate, per hour	.. Rs. 3	Rs. 4	Rs. 3.5
Units issued for production	.. 2,500	2,200	2,600
Time allowed per 100 units	.. 2 hrs. 36 min.	3 hrs.	1 hr. 30 min.
Time taken	.. 52 hrs.	75 hrs.	48 hrs.
Rejects	.. 100 units	400 units	400 units

(I. C. M. A., Pt. II—Adapted)

51. A job can be done in 15 minutes by an average worker. Give three different methods of payment by results and show the cost per article for each method if the job is done in 10 minutes. (Assume basic time-rate of Rs. 4 per hour).

(I. C. M. A., Inter—Adapted)

52. Standard labour rate per hour is Rs. 2.50 and the standard output per day of 8 hours is 200 units. 80% of the standard piece rate is paid if actual output is less than 80% of this standard output. Actual output between 80% and 120% of standard output is considered as normal and paid at standard piece rate. 150% of the standard piece rate is payable if actual output is 121% or above the standard output. In addition, the workers are entitled to Rs. 50 per week as Dearness Allowance. Additional Allowance of Rs. 3 per day is payable if actual daily production exceeds the standard output. Actual output of two workers, Suresh and Ramesh, per day during Week No. 43 are as under :

Day	Output in Numbers	
	Ramesh	Suresh
Monday	150	140
Tuesday	180	220
Wednesday	200	160
Thursday	240	210
Friday	230	225
Saturday	250	245

Your are required to find out (a) Earnings of Suresh and Ramesh for Week No. 43 and (b) Average cost per unit of output for the week in respect of Suresh and Ramesh

(I C W 4, Inter)

53. Ten men are working as a group on a particular manufacturing project. When the weekly production of the group exceeds a standard number of pieces per man hour, each man in the group is paid a bonus for the excess production, in addition to his wages at hourly rates. The amount of bonus is computed by first determining the percentage by which the group's production exceeds the standard. One half of this percentage is then applied to a wage rate of Rs. 8 to determine an hourly bonus rate, irrespective of the variation in individual hourly wages rates. Each man in the group is paid, as a bonus, this bonus rate applied to his total hours worked during the week. The standard rate of production before a bonus can be earned is 200 pieces per man-hour.

On the basis of the production record stated below, compute :

- the rate and amount of bonus for the week,
- the total wages of 'A' who worked 40 hours at a base rate of Rs. 6 per hour and of 'B' who worked 39 hours at a base rate of Rs. 9 per hour

	Man-hours	
	Worked	Production
Monday	72	17,680
Tuesday	72	17,348
Wednesday	72	18,000
Thursday	72	18,560
Friday	71.5	17,888
Saturday	40	9,600
	399.5	99,076

- How much is the labour bonus cost to be attached to each unit of the week's production?

(I. C. W. A., Inter)

54. The standard production in Pressright company is 20 units per hour. For the first week in April, worker's record was as follows :—

Monday	140 units—8 hours
Tuesday	160 units—8 hours
Wednesday	175 units—8 hours
Thursday	180 units—8 hours
Friday	200 units—8 hours

You are required to draw up a schedule showing the worker's daily earnings, the effective hourly rate and the labour cost per unit, if the company uses :

- Halsey Premium Plan with a guaranteed rate of Rs. 4.50 per hour and a premium of 60% of the time saved on production in excess of standard ; or

- (b) The Taylor Differential Piece rate system with rates of 20 paise per unit below standard, 24 paise at standard and up to 20% above standard and 30 paise per unit for all production when daily output exceeds 20% above standard.

(I. C. W. A., Inter)

55. From the following comparative statements for the years 1961 and 1962 :

- (a) Find out whether the year 1962 showed an overall better performance or otherwise.
(b) Possible cause of differences in performance.

	1961	1962
Wages incurred	Rs. 1,80,000	Rs. 5,10,000
Units produced	14,000	25,000
Average number of workers	225	400

(Assume production of only one quality and same machinery conditions in both years).

(I. C. W. A., Inter)

56. In Production Department PDX, 4 direct workers are engaged on the basic wages per month of Rs. 350, Rs. 400, Rs. 450 and Rs. 500 respectively. In addition to these, they are entitled to Dearness Allowance of Rs. 250 up to Rs. 400 basic and Rs. 300 per month over basic wages of Rs. 400. They are also entitled to 10% House Rent Allowance on the basic wages. Workers contribute 10% of their basic wages plus Dearness Allowance towards Provident Fund and the company also contributes an equal amount. Bonus is paid at the rate of 12% on the basic wages plus Dearness Allowance. The factory works for 48 hours a week, for 52 weeks in a year. Each worker is entitled to 2 weeks' paid leave. Out of the available hours, 10% is considered as normal idle time, to take care of tea breaks, going to toilet, reaching the work place etc.

During the 5th month of 4 weeks, 2 workers were on leave for 2 weeks each and the total idle time of the department was 70 hours.

Your are required to :

- (a) Calculate comprehensive labour rate for Production Department, and
(b) Calculate the under over recovery of direct wages during 5th month of 4 weeks.

(I. C. W. A., Inter)

57. Bharat Garment Corporation produces garments of the same size and style. Employees are paid wages at Rs. 2.50 per hour for an eight hour shift. They produce five units per hour per employee. The overhead in this department is Rs. 3 per direct labour hour. The employees and the management are considering the following piece-rate proposal :

Up to 45 units per day of 8 hours	—50 paise per unit
From 46 units to 50 units	—53 paise per unit
From 51 units to 55 units	—55 paise per unit
From 56 units to 60 units	—57 paise per unit
Above 60 units	—60 paise per unit

The working hours are restricted to 8 hours per day. Overhead rate does not change with the increased production.

Prepare a statement indicating the advantages to the employee as well as the management at the production levels of 40, 45, 50, 55, 60 and 65 units.

(I. C. W. A., Inter)

58. Prosperous Ltd. manufacture a single product. Its condensed Profit and Loss statement for the year ending 31st December 1976 is as follows. (No inventories were on hand at the beginning and end of the year.)

	Rs.	Unit cost (Rs.)
Sales (10 lakh units produced sold)	45,00,000	
Materials	12,00,000	1.20
Direct Labour (3,00,000 hours)	6,00,000	0.60
Variable Overhead	2,00,000	0.20
Fixed overhead	8,00,000	0.80
Factory Cost	28,00,000	
Gross Profit	17,00,000	

Selling and Distribution expenses :

Variable	Rs. 4,00,000	
Fixed	Rs. 9,00,000	13,00,000
Net Profit		<u>4,00,000</u>

In January 1977, the company's management was engaged in negotiations with the union representatives. The company's Industrial Engineer claimed that if a straight piece work plan were adopted instead of the present hourly wage rates, labour productivity could be expected to rise by 10%. The union had demanded a 10% increase in hourly rates. It now indicates its willingness to accept a piece rate system, provided the rate per piece is established at Re. 0.70. From the company's standpoint, which of these two alternatives is more profitable assuming that 1977 costs would adhere to the same pattern as in 1976 except for labour? (I. C. W. A., Inter)

59. Both direct and indirect labour of a department in a factory are entitled to production bonus in accordance with a Group Incentive Scheme, the outlines of which are as follows :

(a) For any production in excess of the standard rate fixed at 10,000 tonnes per month (of 25 days) a general incentive of Rs. 10 per tonne is paid in aggregate. The total amount payable to each separate group is determined on the basis of an assumed percentage of such excess production being contributed by it, namely, @ 70% by Direct Labour, @ 10% by Inspection staff, @ 12% by Maintenance staff and @ 8% by Supervisory staff.

(b) Moreover, if the excess production is more than 20% above the standard, direct labour also gets a special bonus @ Rs. 5 per tonne for all production in excess of 12% of standard.

(c) Inspection staff are penalised @ Rs. 20 per tonne for any rejection by customer in excess of 1% of production.

(d) Maintenance staff are also penalised @ Rs. 20 per hour of machine breakdown. From the following particulars for a month, work out the production bonus earned by each group.

(a) Actual working days — 20

(b) Production — 11,000 Tonnes

(c) Rejection by customers — 200 Tonnes

(d) Maintenance breakdown — 40 hours

(I. C. W. A., Inter)

60. The Empire Pipe Company manufactures a line of smoking pipes at its plant. All direct and indirect labourers except supervisors are paid on an hourly basis. Labour costs are controlled by management through a Labour Efficiency Report as shown below :

Monthly Labour Efficiency Report

	This month Rs.	Last month Rs.
Direct Labour	24,400	28,080
Supervision	3,000	3,000
Material handling	2,800	3,100
Inspection	3,600	3,820
Maintenance and repair labour	3,200	3,200
Clerical	2,400	2,400
Total Labour Costs	<u>39,400</u>	<u>45,600</u>
Labour costs as a percentage of sales value of production	29.0%	26.3%
Sale value of production	1,36,000	1,66,000

From this can you definitely say whether there has been an improvement or deterioration in labour efficiency? What factors might have caused the change in the percentage relationship between labour costs and the sales value of production. What is your opinion on the value of this type of report? Can you suggest a better way to control labour costs? (I. C. W. A., Inter)

CHAPTER 4

OVERHEAD COSTS

Direct and Indirect Costs. Costs pertaining to a cost centre or a cost unit may be broadly divided into two portions, viz. direct and indirect. Items of cost like direct material, direct labour, and direct expenses, which are attributable to or which can be identified with particular cost centres or cost units, may be allocated (i.e., they may be charged direct) to such centres or units. The indirect portion of total costs constitutes the overhead cost, which is the aggregate of indirect material costs, indirect wages, and indirect expenses. Thus, overhead forms a class of cost that cannot be allocated or absorbed but can only be apportioned to cost units. Overhead costs are also apportioned and sometimes allocated to cost centres. Overhead costs are known by several other names, e.g. manufacturing expenses, works expenses, establishment expenses, on-cost, burden, indirect charges, etc. In this text, the terms, overhead cost, overhead expenses, and overhead charges have been used and the terms, factory overhead and manufacturing overhead have been used to denote overhead pertaining to the factory or manufacturing process. The separation of indirect costs from direct costs is necessary not only because each of these two elements of cost needs different treatment in the matter of accounting and control but also because most cost accounting techniques meant to assist the management in decision making consider such segregation essential while analysing costs.

In most cases it is possible to classify expenditure into direct and indirect but the separation of overhead costs from direct labour and direct material costs in some border-line cases presents a problem. It becomes difficult to lay down a hard and fast line and what may be taken to be overhead cost in one factory may be allocated direct to cost units in another and accepted as an item of direct labour or direct material costs. For example, cost of small items like nails, glue, etc. in a furniture making factory, or cotton thread in a shoe-making factory may be treated either as direct material cost or as overhead. Similarly, some petty labour operations may be treated as overhead costs in one factory but as direct labour costs in another. In some undertakings, the procedure adopted is to treat the wages of operators engaged on tending automatic machines as indirect machine expenses.

In general, therefore, the distinction between direct costs and indirect costs lies in the traceability of an item of cost to an activity, department, product or any other cost objective. Sundry materials and supplies, material transport, salaries etc. may be treated as indirect costs in a jobbing factory. In a processing factory, most of these items of costs will be treated as direct since they can be identified with the process. In the case of joint products, the costs incurred up to the point of separation (which include raw material and wages costs) may be treated as indirect since these can only be apportioned to the several joint products and no portion thereof is identifiable or traceable to any particular product.

Based on the above considerations, indirect costs may be broadly classified into three types :

- (i) Costs that are intrinsically indirect by nature and are usually not traced or allocated direct to cost units unless specifically desired for any purpose, e.g. indirect material, indirect labour, idle time, and material shortages and adjustments.
- (ii) Indirect costs that may, if so desired, be allocated direct with some difficulty but such a procedure would involve avoidable clerical effort and expenditure. Examples are, carriage in, sundry raw materials of small value etc.
- (iii) Costs that may without difficulty be allocated direct but are more appropriately treated as indirect costs such as overtime premium, shift differential (e.g., extra payment for night shift work), holiday pay, and spoiled work.

With the modern trend towards increased mechanisation, automation, and mass production, overhead costs have grown considerably in size and in many undertakings the proportion of overhead costs to the total costs of products is appreciably high. High overheads do not indicate inefficiency if the increase in expenditure is due to the following likely causes : —

- (i) Improved methods of managerial control like accountancy, production control, work study, cost and management accountancy etc. In the process of reducing costs of the other elements, viz. direct material and direct labour, overhead costs are likely to increase.
- (ii) Large scale production or mass production.
- (iii) Use of costly machines and equipments increases the amounts of depreciation, maintenance expenditure, and similar other items of overhead costs.
- (iv) Less human efforts are necessary with automatic machines. A major portion of the cost is allocated direct to machines, thus increasing the machine overhead costs.
- (v) Increased efficiency and productivity of labour has the effect of pushing up the 'overhead to direct labour' ratio.

The various steps involved in the accounting and control of overhead costs are :

1. Classification ;
2. Codification ,
3. Collection ,
4. Allocation and apportionment to cost centres ; and
5. Absorption in costs of products, services etc.

Classification of Overhead Costs. The first step in the accounting and control of overhead costs is to classify all indirect expenditure under suitable groups. Classification involves two processes ; firstly, the specification of definite groups according to which the expenses should be classified and secondly, the placing of several types of expenses into one or the other of these groups according to their common characteristics.

Overhead costs may be classified or grouped in accordance with the methods detailed below. The particular method or methods selected in an undertaking

would depend upon various factors such as the type of business and the nature of production or service rendered, size of the concern, and the policy of the management.

- (1) Classification according to the *major functions* of the business, viz. manufacturing, administration, selling, and distribution overhead.
- (2) Classification with regard to the *behaviour of the expenditure* with changes in the level of activity of the concern, i.e. fixed, variable, and semi-variable or semi-fixed costs.
- (3) *Elementwise* classification into indirect material, indirect labour, and indirect expenses.
- (4) Classification according to the *nature of expenditure*, e.g. salaries, depreciation, repairs, maintenance, power etc.

Depending upon its requirements, a concern may adopt one or more, or all of the above bases of classification. For example, the entire overhead expenses in a concern may be first divided into the manufacturing, administration, selling and distribution divisions; the expenses pertaining to say, the manufacturing division may be further classified into fixed, variable, and semi-variable; each of these may then be grouped into the elements, viz. indirect labour, indirect material, and indirect expenses and under each element, the expenses may be further subdivided according to their nature, e.g. salary, depreciation, maintenance, etc.

Functional Classification of Overhead. Costs may be classified according to the functional divisions of a manufacturing business. The overhead expenses pertaining to the main functional divisions may be segregated and classified as follows :—

- (a) *Manufacturing Overhead* (Also known as *Factory, Production, or Works Overhead*)
- (b) *Administration Overhead*
- (c) *Distribution Overhead*
- (d) *Selling Overhead*

Apart from the segregation of costs of each of the main functions of the business, necessity for such classification arises out of the fact that the characteristic nature of expenses in each division needs diverse methods of accounting and control.

Manufacturing or Production costs refer to the costs of operating the manufacturing division of an undertaking and include all costs incurred by the factory from the receipt of raw materials and supply of labour and services until production is completed and the finished product is packed with the primary packing. Manufacturing costs cover direct material, direct labour, direct expenses, and all overhead expenses relating to production.

Manufacturing overhead is the indirect cost, (i.e. indirect material, indirect labour, and indirect expenses) incurred for operating the manufacturing or production division of a factory. It includes all overhead costs incurred from the stage of procurement of materials till the completion of the finished product but

excludes expenses on selling and distribution and administration unless the latter are merged with manufacturing overhead and are not maintained as a separate class of overhead cost. Some typical examples of manufacturing overhead are given below :

Depreciation of factory buildings	Insurance of plant and machinery
Depreciation of plant, machinery, and other equipments	Overtime (in the factory)
Factory heating, lighting, and air-conditioning	Power (in the factory)
Fuel	Rent of factory buildings
General purpose tools	Repairs and maintenance of plant, machinery, and factory buildings
Idle time	Stock keeping expenses
Indirect shop labour	Sundry consumable stores

Administration, selling and distribution overhead costs are discussed in Chapter 5.

Classification of Overhead Expenses according to their Behaviour with (or Reaction to) Changes in the Volume of Output. While some costs are not affected by any changes in the volume of production, others vary in amount in sympathy with the output. Based on this behaviour, overhead costs are classified into three groups, viz. Fixed, Variable, and Semi-Variable or Semi-Fixed Overhead.

(a) *Fixed overhead.* Subject to certain limitations, the amount of fixed overhead tends to remain constant for all volumes of production within a certain range. Examples of fixed overhead are :

Audit fees	Interest on capital
Bank Charges	Legal expenses
Canteen	Office expenses
Cost of Hospital, Dispensary, and Factory Estate	Pay and allowances of officers and staff
Depreciation of plant, machinery, and buildings	Pension and superannuation charges
Insurance	Rent of buildings, storage space, etc

As fixed overhead represents constant expenditure incurred during a period without regard to the volume of production during that period, it follows that even when production completely ceases in a particular period, this constant amount of expenditure will continue to be incurred partially, if not wholly. Fixed overhead costs are, therefore, also known as *Period Costs*. Sometimes they are also termed as *Shutdown or Stand-by Costs*.

Fixed costs are stated to be, by and large, uncontrollable in the sense that they are not influenced by the action of a specified member of an undertaking. The foreman of a department has practically no control over the fixed costs pertaining to his department as no amount of efficiency on his part can reduce such costs. The utmost he can do is to make optimum use of the resources provided out of the fixed expenditure. To quote an example, the cost of depreciation of plant and machinery cannot be controlled except to the extent of seeing that the maximum possible utilization of the assets is made.

Another characteristic of fixed overhead is that although the amount is constant per period, the cost per unit of production varies with the volume. This variation is inverse since with increase in production, cost per unit decreases as the same amount of fixed cost is spread over larger units of production. Similarly, costs rise with decrease in the volume of production. The change in unit cost at

various levels of production is illustrated in the following table. The activity level has been expressed in percentage capacity as well as in units of production and labour hours.

Capacity (%) Units of product Labour hours	Activity Level			
	60	80	100	120
	1,200	1,600	2,000	2,400
	3,600	4,800	6,000	7,200
Fixed overhead	Rs. 2,500	2,500	2,500	2,500
Variable cost	Rs. 1,200	1,600	2,000	2,400
Total cost	Rs. 3,700	4,100	4,500	4,900
Total cost per unit	Rs. 3 08	2 56	2 25	2 04
Fixed overhead cost per unit	Rs. 2 08	1 56	1 25	1 04
Variable overhead cost per unit	Rs. 1 00	1 00	1 00	1 00

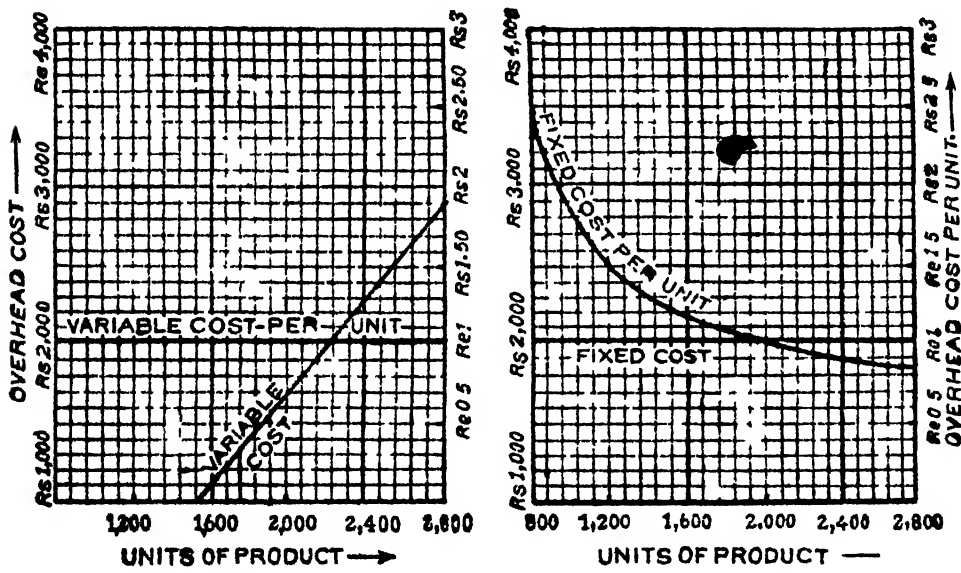


Fig. 4 1. Fixed and variable costs (Total and unit costs)

Expressed graphically (See Fig. 4.1), fixed cost is represented by a straight line parallel to the horizontal axis and the fixed cost per unit by a hyperbola.

Fixed overhead is not always absolutely fixed. When a plant or a department is completely idle and there is no production several items of fixed overhead disappear. Some fixed costs still continue to be incurred, but it is seen that as soon as production is resumed, this amount of fixed overhead is no longer sufficient to meet the needs of current production. For instance, maintenance expenditure incurred at plant shutdown has to be increased to a higher level when production starts. Fixed overheads are thus, of two types, viz. a lower standing fixed cost when production is nil and a higher running fixed cost when the plant is running.

Any long-term change in the productive capacity of an undertaking also affects the basic characteristic of fixed overhead. When new projects are undertaken or some existing production lines are discarded, or when modernisation or expansion schemes are put into effect, there is a radical change in the existing

resources, and with the change in the level of activity, fixed overhead also undergoes a change. We have, therefore, to modify the definition of fixed overhead and to state that fixed costs are constant for short-term periods only within a limited range of capacity.

Another factor that affects the fixed nature of fixed overhead is the change in basic price level. The amount of rent, rates, and taxes may, for instance, increase or decrease irrespective of whether or not there is any change in the volume of production. Similarly, the pay structure of the employees may undergo a change say, by an alteration in pay scales or in the rate of allowances, or by payment or withdrawal of particular allowances. Periodical increments in salary also affect the character of fixed costs. Violent changes in material price levels may also affect fixed overhead expenditure.

Fixed costs may be broadly classified into three basic types :

- (i) Fixed costs that have no causal relationship with the volume of output and are incurred mainly as results of policy decisions of the management. Research, development, design, employee training, advertisement, and market research expenses are examples of this type of fixed costs. Accountants term such costs as *discretionary fixed costs* (also known as *programmed costs* or *managed costs*), since depending on the availability of funds, the incidence of expenditure is at the discretion of the management. If circumstances so demand, no expenditure need at all be incurred under any of these heads. Budgets for discretionary fixed costs would be mainly of the appropriation type where the total amount to be spent is appropriated depending upon the policy of the management and not related to the volume of production.
- (ii) Fixed costs that do not change significantly in the short-term, such as depreciation, rent, etc.
- (iii) Fixed costs that are fixed for short period for a particular capacity but change considerably when there is a long-term change in the volume or capacity. Examples are pay and allowances of staff, office expenses, etc.

The expenses under heads (ii) and (iii) are also called *committed fixed costs*. The management is committed to incur the expenditure even when the volume drops or when there is total shutdown for a brief period.

(b) *Variable overhead*. Variable overhead costs tend to increase or decrease in sympathy with changes in output although the variation may not always be in the same proportion. Examples of variable overhead are :

Fuel	Lubricants
Indirect labour	Overtime
Indirect material	Power
Internal transport	Stores handling and stores losses
Lighting, heating, and air-conditioning	Tools and spares

Although the amount of variable overhead expenditure varies, the cost per unit tends to remain constant at all volumes of output (See Fig. 4.1). This is, however, true only for a limited range of volume change and if this range is significantly large, the linear variation of the variable expenses is no longer valid and

the cost per unit fluctuates. For instance, if the purchase of larger quantities of indirect materials and sundry stores are subject to quantity discount, the costs will decrease if production increases sharply and vice-versa.

Besides the variable overhead, direct material and direct labour costs also change with variations in the volume of output. In fact, direct material cost variations are almost always directly proportionate to volume changes at all levels of capacity unless there is a basic change in material prices or in product specifications. Labour costs also fluctuate directly with volume except when there is a change in the wage structure or where wage payment is based on a system in which the wages paid are not in direct proportion to the efforts of the workers. In any case, variable costs have a specified relationship with volume of production or any selected measure of activity and in this respect they are termed by many accountants as *engineered costs*. An item of cost is said to be engineered when a specific relationship between the inputs and outputs has been established, in the form of standards by engineering analysis or by an analysis of the historical data. It should, however, be noted that variable costs and engineered costs are mainly interchangeable terms but not always so because there may be some variable cost which may be incurred as a matter of policy of the management and so it may not have a specific relationship with activity. Such costs are discretionary variable costs. For example, repair and maintenance costs though basically not related to activity level, may have a discretionary variable component in the sense that the management appropriates higher amounts for repairs during periods of increased activity.

(c) *Semi-variable (or Semi-fixed) Overhead Costs*. These are a sort of mixed or hybrid costs - partly fixed and partly variable. No costs are truly fixed or truly variable. We have seen that under certain circumstances, both fixed and variable costs change their basic characteristics. Some items of variable overhead contain a fixed element and similarly, a part of the fixed overhead tends to vary with output level.

Semi-variable costs may be classified under four basic types :

- (i) Expenses which are of a mixed character and possess the characteristics of both fixed and variable costs and cannot, therefore, be placed straightway in either category. Examples of such partly variable and partly fixed expenses are indirect labour, maintenance and repair expenses, general stores, and power cost.
- (ii) The relationship between the semi-variable cost and volume is neither linear nor curvilinear but takes the form of steps, i.e. when there are major changes in the volume of output, the costs may jump in steps. For example, an increase in volume may be accompanied by an increase in the strength of the supervisory staff or the working of an additional shift ; within a certain range of output, the costs are fixed but they change as soon as a new range is reached. One supervisor may supervise the work of ten production line workers but when the number of workers exceeds ten, another supervisor is added. Such

semi-variable costs are also known as *Stepped* or *Stairstep costs* (see Fig 4.2). For all practical purposes, however, the cost at each step, i.e. at each individual range of volume is treated as fixed; though semi-variable on a longterm basis such costs are fixed in the short-term.

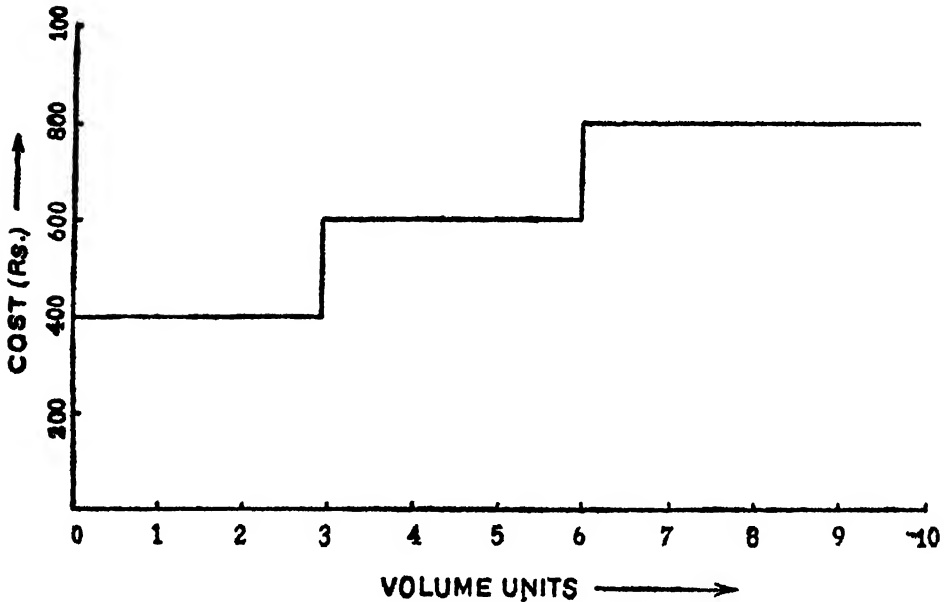


Fig 4.2 Stepped or Stair Step Costs

- (iii) Certain costs of a semi-variable nature tend to be higher or lower during specific periods for reasons not related to volume, e.g. cost of heating, air-conditioning, and lighting may be seasonal (lighting cost may be higher during the winter months) or machine maintenance and repairs may be undertaken only during certain periods according to convenience.
- (iv) Costs become semi-variable when, with increases in volume, they increase in a non-linear way, i.e. at an accelerated or retarded rate. This happens particularly when the maximum operating capacity is reached or exceeded; further increase in cost is not proportionate to the increase in volume.

Costs of utilities (water, steam, electric power etc.) often increase at a decreasing rate. For instance, the cost of electricity per unit may be Re. 0.60 for consumption between 50 and 100 units, Re. 0.40 for consumption between 101 and 500 units, Re. 0.20 for consumption between 501 and 2,000 units and so on. On the other hand, some costs such as demurrage charges increase at an increasing rate. Non-linear variations of cost, may be shown graphically as in Fig. 4.3.

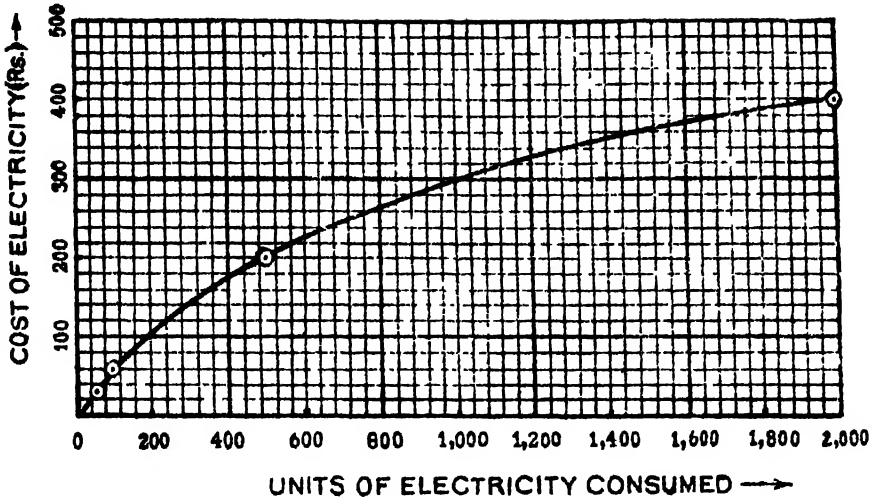


Fig. 4.3. Nonlinear Overhead Cost

Methods of Segregating Fixed and Variable Overhead Costs. In order to study cost behaviour, it suffices to separate the overhead expenses into two categories only, viz. fixed and variable. For all practical purposes of accounting and control, therefore, the semi-variable expenses are required to be further analysed and separated into their fixed and variable elements. Since such an analysis is a complicated one needing much clerical and management effort and time, some concerns do not make any attempt to resolve the semi-variable overhead into its constituents but each item is taken up for examination individually and depending upon its degree of variability, it is categorised either as fixed or variable. The problem of separation of semi-variable costs of the step type does not arise, these being usually classed as fixed costs.

Basically, the method of analysis and separation of fixed and variable costs consists in finding out first, the amount of fixed cost in an item of expenditure and then determining its variability with output. The simplest method, wherever feasible, is to pick up and identify each item by an inspection of the accounts. However, there are several techniques available for measuring the variability pattern of costs and separating the fixed and variable costs, a few of which are discussed below.

1. *Method of simultaneous equations.* The equation for relating costs to volume is $y = mx + c$, where, y = total cost, x = volume of output, c = fixed cost, and m = slope of the variable cost line, i.e. variable cost per unit of output.

This may also be represented by a straight line on a graph, as shown in Fig. 4.4.

For the purpose of separating fixed and variable expenses, the expenditure against an item is determined (either historical or predetermined cost is taken for the purpose) at various levels of output and pairs of values of x and y are

fitted in the above formula in order to compute the values of m and c . This is illustrated below :

	Level of activity	
Capacity (%)	80	100
Volume (Labour hours), x	200	250
Semi-variable expenses (Maintenance of plant), y	Rs 1,300	Rs. 1,375
Substituting the two sets of values of x and y in the equation, $y = mx + c$, we have,		
$1,300 = m \times 200 + c$		
$1,375 = m \times 250 + c$		
On solving the equations, we get the following values		
Fixed cost, $c = \text{Rs } 1,000$		
Variable cost per unit, $m = \text{Rs } 1.50$ per labour hour		
Cost formula is : Rs 1,000 per period + Rs. 1.50 per labour hour		

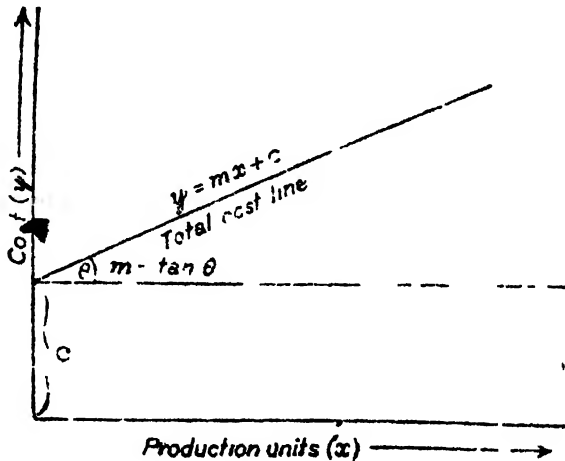


Fig 4.4 Total Cost Line

The simultaneous equations method affords a simple and easy means of separating fixed and variable overhead costs, but it has the following limitations :—

- (i) It assumes a linear relationship between output and variable overhead costs, viz. that for each unit of output the same amount of variable overhead cost is incurred. In practice, this may not be so.
- (ii) Different results are obtained by taking different sets of data for volume and overhead cost. It cannot be definitely said that the particular data selected will give the most accurate result.

2. Charting a scatter diagram (scatter graph) or tracing the regression line.

The costs at a number of levels of output are plotted on a graph, the x axis of which represents the volume (expressed in terms of percentage activity, labour hours, units of products, or machine hours) and y axis, the amount of expenditure.

A straight line, known as the line of regression or the line of best fit, is drawn between the points plotted in such a manner that there are equal number of points on both sides of the line and as far as practicable, pairs of points on either side are equi-distant from the line. Points falling far beyond the line are erratic and are not considered for the purpose.

If the points are very much erratic, it would be impossible to draw a regression line. This will indicate that either the costs under consideration cannot be segregated

into the fixed and variable components or the activity base selected for drawing the scattergraph is not suitable for the purpose.

This is illustrated in the example given below :

EXAMPLE 4.1.

The annual historical data in respect of costs and direct labour and machine hours collected for one of the production shops of a company are given below. The management wants to know which of the two activity bases, i.e. whether direct labour hour or machine hour is more suitable for determining the behaviour of the costs.

	Costs Rs.	Direct labour hours	Machine hours
January	36,000	3,000	2,700
February	28,000	3,000	5,000
March	42,000	4,000	2,000
April	38,000	3,400	4,000
May	43,000	4,300	2,700
June	46,000	4,800	5,600
July	48,000	4,600	4,000
August	43,000	4,700	2,700
September	50,000	5,100	4,600
October	60,000	6,500	3,000
November	54,000	5,400	3,000
December	54,000	5,200	2,000

- Draw suitable scattergraphs to determine the fixed and variable elements of costs, and
- State which base would be more appropriate for future cost estimation purposes.

ANSWER :

The scattergraphs taking (i) direct labour hours and (ii) machine hours as the base are shown in Fig. 4.5

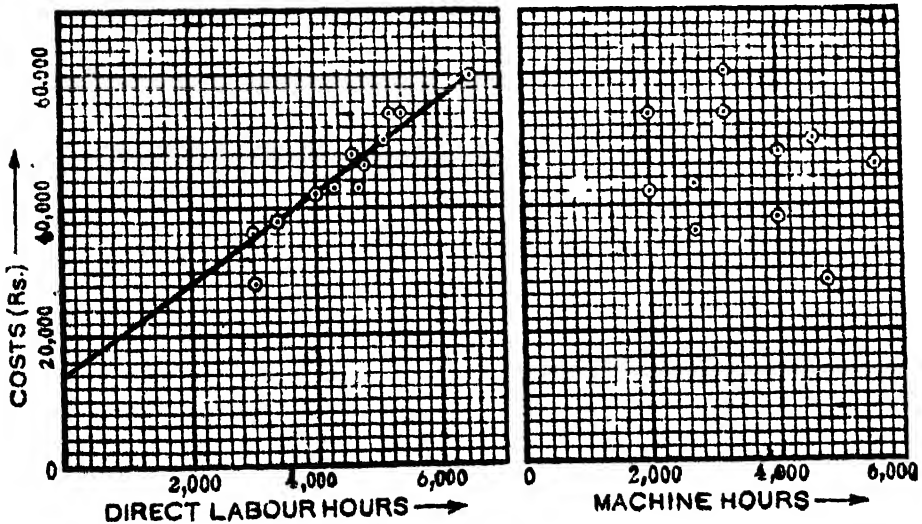


Fig. 4.5. Scatter graph

It will be seen that with direct labour hours as the activity base, a line of best fit may be drawn. The slope of the regression line represents the degree of variability of the costs and the point where it cuts the ordinate denotes the amount of fixed cost—Rs. 14,000 in this case.

In the diagram drawn by taking machine hours as the base, no regression line can be drawn. This base is, therefore, not suitable for future cost estimation purpose.

If the regression line is drawn carefully so that most of the plotted points are on the line or not far from it, the scatter chart provides a fairly accurate method for the separation of fixed and variable overhead.

3. *High and low points (or interpolation) method.* This method is similar to the method of simultaneous equations. The difference between the highest and lowest volumes over a contemplated relevant range and the difference of the corresponding costs are worked out and the variable and fixed costs are separated in the following manner. (The figures in Example 4.1 have been taken to illustrate the method.)

Highest volume	=	6,500	Corresponding cost	Rs. 60,000
Lower volume	=	3,000	.. ..	Rs. 36,000
Difference	=	3,500		Rs. 24,000
		Rs. 24,000		
Variable cost	=	Rs. 6.86 per direct labour hour		
		Rs. 3,500		
Fixed cost	=	Rs. 60,000 — Rs. 6.86 × 6,500 = Rs. 15,410		

Note that the data for February being abnormal has not been taken as the minimum.

Besides the limitations which we come across with the method of simultaneous equations, the high and low points method has the following *shortcomings* :—

- (i) If the high or low points are at the extreme, the results obtained are not likely to be correct.
- (ii) If high or low levels of activities occur for very short periods only, the corresponding data for overhead costs incurred are not truly representative.
- (iii) The analysis may be distorted if any abnormal costs are incurred during the periods selected.

4. *Method of Averages.* In order to overcome the distortion caused by any abnormal costs incurred during either of the two levels selected, the method of averages is used. In this method, the cost line is drawn on a graph by taking the averages of selected groups. With the averages taken from the foregoing example, the figures would work out as shown below.

	Cost Rs.	Direct Labour Hours
Average : January to June (Leaving out February which is abnormal)	41,000	3,900
July to December	51,500	5,250

The above two points when plotted on a graph (Fig. 4.6) represent the cost line from which the fixed and variable costs may be determined.

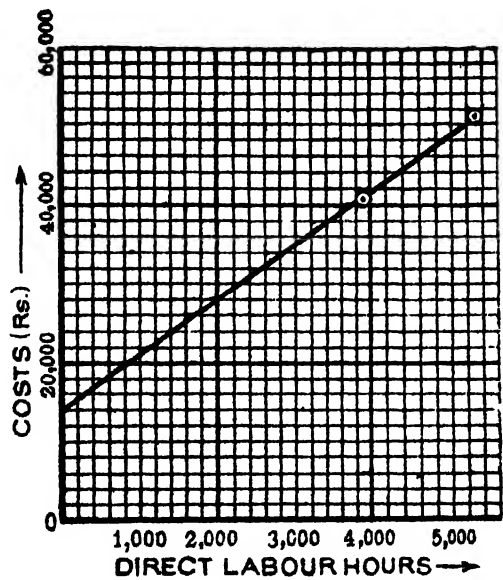


Fig. 4.6. Separation of Fixed and Variable Costs—Method of Averages

5. *Method of Least Squares (Simple regression analysis).* Instead of relying on visual inspection, the line of regression may be determined by the more accurate statistical method of least squares (also known as simple regression analysis).

The method is illustrated below with data assumed as follows :—

Period	Volume (Sales) Rs.	Overhead Cost Rs.
1	40,000	30,000
2	50,000	32,000
3	60,000	34,000
4	55,000	35,000
5	70,000	36,000
Total	Rs. 2,75,000	Rs. 1,67,000

First, the mean of volume and the mean of costs are computed. In the illustration, these will be $2,75,000/5 = 55,000$ and $1,67,000/5 = 33,400$ respectively.

Next, the deviations of volume in each period from the mean volume and the deviations of cost from the mean cost are calculated as x and y respectively and noted in the following table :

Period	Volume (Sales) Rs. '000	Cost Rs. '000	Deviation of volume from mean (x)	Deviation of cost from mean (y)	(xy)	(x ²)
1	40	30	(-) 15	(-) 3.4	51	225
2	50	32	(-) 5	(-) 1.4	7	25
3	60	34	5	0.6	3	25
4	55	35	0	1.6	0	0
5	70	36	15	2.6	39	225
Total	275	167	0	0	100 (Σxy)	500 (Σx^2)

Variable cost will be represented by

$$\frac{\sum xy}{\sum (x^2)} - \frac{100}{500} = \text{Rs. } 0.2 \text{ per rupee of sales}$$

$$\text{Fixed cost} = 33,400 - 0.2 \times 55,000 = 22,400$$

$$\text{Line of regression is, } y = 0.2x + 22,400$$

The scatter graph enables visual verification of the degree of correlation that exists between the independent variable (here x , the measure of activity) and the dependent variable (here y , the costs). If all the plotted points fall on the regression line, perfect correlation would exist. The exact degree of correlation may, however, be measured mathematically

In theory of statistics, the *coefficient of correlation* (r), measures the linear relationship between two variables. The value of r varies between 0 and ± 1 . Where $r = 0$, no correlation between the variables exists. Where $r = \pm 1$, maximum correlation exists; $r = +1$ indicates that y increases with increase in x and $r = -1$ indicates that y decreases with increase in x .

The formula for coefficient of correlation is,

$$r = \frac{n\sum xy - [(\sum x)(\sum y)]}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where, x is independent variable,
 y is dependent variable, and
 n is the number of observations made.

Coefficient of correlation when squared, i.e. r^2 , denotes the *coefficient of determination* that represents the percentage of variance between the variables. For example, $r^2 = 0.60$ would mean that 60% of change in y (costs) is related to the change in x (volume or activity say, labour hours) and the remaining 40% of the costs is related to factors other than the activity represented by x , say machine hours.

The method of calculating r is illustrated with the help of the assumed data given below (Two independent variables x_1 and x_2 have been taken) :

	Machine hours (x_1) (in thousands)	Direct labour hours (x_2) (in thousands)	Power Cost (y) (in Rs. thousand)	x_1y	x_2y	x_1^2	x_2^2	y^2
Month								
January	4.0	4.9	2.5	10.00	12.25	16.00	24.01	6.25
February	4.5	5.8	3.0	13.50	17.40	20.25	33.64	9.00
March	4.2	5.4	2.8	11.76	15.12	17.64	29.16	7.84
April	4.5	4.8	2.9	13.05	13.92	20.25	23.04	8.41
May	4.6	5.6	3.1	14.26	17.36	21.16	31.36	9.61
June	4.4	5.1	2.9	12.76	14.79	19.36	26.01	8.41
	<u>26.20</u>	<u>31.60</u>	<u>17.20</u>	<u>75.33</u>	<u>90.84</u>	<u>114.66</u>	<u>167.22</u>	<u>49.52</u>
	($\sum x_1$)	($\sum x_2$)	($\sum y$)	($\sum x_1y$)	($\sum x_2y$)	($\sum x_1^2$)	($\sum x_2^2$)	($\sum y^2$)

For x_1 ,

$$r = \frac{6 \times 75.33 - 26.20 \times 17.20}{\sqrt{[6 \times 114.66 - (26.20)^2] [6 \times 49.52 - (17.20)^2]}} = \frac{1.34}{\sqrt{1.9456}} = 0.9607$$

$r^2 = 0.9229$, i.e. 92.29% of power cost is related to machine hours.

Similarly for x_2 , $r^2 = 0.3792$

Thus in this case, power cost is closely related to machine hours.

Necessity for Classification of Costs into Fixed and Variable. The necessity for the classification of costs into fixed and variable, arises from the following :—

- (a) *Effective cost control* : We have seen that fixed costs are in the nature of policy costs or discretionary costs and are mostly non-controllable at the shop level. If at all any control can be exercised, it can be done by the top level management only. Variable costs, however, can be controlled at lower levels. Separation of the two elements, therefore, facilitates fixation of responsibility, preparation of overhead budgets, and exercise of effective control.
- (b) *Decision making* . The main problems of decision making are related to changes in the levels of activity. If cost information is to be of use in such problems, it is essential that fixed and variable costs which behave differently with changes in volume should be segregated.
- (c) *Preparation of break-even charts* : Separation of fixed and variable costs is essential for the study of cost-volume-profit relationship and for the preparation of break-even charts and profit charts.
- (d) *Marginal costing* : The basic requirement of the technique of marginal costing is the separation of fixed and variable costs. While the latter are taken into consideration for the determination of marginal costs and contribution, the fixed costs are treated separately in lump to be met out of the total contribution.
- (e) *Method of absorption of cost* : Separate methods may be adopted for determination of the rates for fixed and variable overhead costs for absorption in production. Further, a separate fixed overhead rate also serves as a measure of utilisation of the facilities of the undertaking : any under-absorption denotes existence of idle or surplus capacity or production efficiency.
- (f) *Flexible budget* : In a flexible budget, the budgeted amounts vary with the levels of activity—while fixed cost remains constant, it is the variable cost budget amount that varies. Break-up of overhead cost into fixed and variable is, therefore, necessary for establishment of budgets and for the purpose of variance analysis.

Limits of the Usefulness of Classification of Cost into Fixed and Variable. The classification of costs in accordance with the behaviour of expenses with changes in volume is not perfect and is less accurate with the result that the

decisions taken on this basis of classification are often impaired. The following limitations are to be noted :—

- (i) In classifying costs into fixed and variable, factors other than volume of output are ignored. Besides output, some of the important factors which make costs vary are the changes in (a) product specification, (b) product mix, (c) plant and equipment (capital range), (d) organisation and personnel, (e) price indices, (f) conditions of efficiency and (g) management policy towards costs. These factors cannot be precisely segregated unless a very detailed and expensive analysis is undertaken.
- (ii) Due to the operation of one or the other of the factors mentioned above at any time, the assumption of linear behaviour of fixed and variable costs is not always true.
- (iii) The analysis of costs into fixed and variable relies heavily upon historical costs.

Elementwise Classification of Overhead Costs. Under this method, the basis of which follows logically from the definition of overhead costs, the expenditure is classified under three heads, viz. indirect labour, indirect material, and indirect expenses. This classification fits in with the internal grouping of the sources or incidence of overhead expenses and the medium or documents through which these are collected. For example, indirect labour pertains to wages of indirect workers and is obtained through payrolls, job cards, time sheets, idle time cards, and allocation sheets (or same job statements when a worker is employed on one particular work throughout the wage period) ; indirect material constitutes consumable stores drawn against material requisitions (or purchased direct for a specific Standing Order Number) ; whereas indirect expenses are obtained from pay bills and other payment vouchers, purchase journal, petty cash book, journal entries (for adjustments), depreciation schedule, defective work tickets, maintenance and repairs orders, insurance analysis, etc.

Expenses that may be grouped under the three classes are listed in the examples given below :

<i>Indirect labour</i>	<i>Indirect material</i>	<i>Indirect expenses</i>
Gratuity	Fuel	(i) Cash outlay items for which payments are made, such as :
Holiday pay	Lubricants	Insurance
Idle time	Repair and maintenance stores	Rent, rates and taxes
Leave pay	Sundry consumable stores	Salary of staff (alternatively, salary of staff may be included as indirect labour, as is the practice in several concerns)
Maintenance and repair wages	Tools for general use	(ii) Adjustment items which do not involve cash outlay, e.g.
Overtime premiums		Depreciation
Provident fund (Employers' contribution)		Interest (not payable)
		Rent (not payable)

Indirect and Direct Expenses. The distinction between indirect expenses and direct expenses should be noted. While indirect expenses are those expenses which cannot be allocated but which can be

apportioned to or absorbed by cost centres or cost units, direct expenses are those which can be identified with and allocated to cost centres or cost units. Direct expenses allocated to cost centres may have to be further apportioned to cost units and thus, they constitute overhead cost or indirect cost so far as cost units are concerned. Direct expenses allocated to cost units form a part of the prime cost. Examples of direct expenses which are directly chargeable to cost units (jobs etc.) are :

- (i) Cost of special tools, patterns, designs, etc.
- (ii) Hire charges of plants and equipments
- (iii) Cost of experiments or pilot schemes
- (iv) Cost of patents, royalty, licence fees, etc.
- (v) Fees for architects, surveyors, etc.
- (vi) Insurance, freight, customs duty, and other charges on special material charged to a job
- (vii) Special plant and machinery for job
- (viii) Components and spare parts procured from outside for a special job.

Classification of Overhead according to the Nature of Expenditure. Overhead costs are classified into a number of specified heads so that items of expenses of a similar nature may be grouped together under one head. This is the smallest sub-division of overhead costs made for the purpose of accounting and control and the classification is done in combination with a system of Standing Order Numbers or Syllabus Numbers.

The heads of expenses under which overhead expenses are to be classified are determined and each class of expenses is allotted a standing order number. Thus, a standing order number denotes a particular type of overhead cost, and expenditure, as and when incurred, is suitably classified under one of these numbers. All the standing order numbers are listed in a schedule or manual. No standard list of standing order numbers can be suggested as the number and types under which overhead may be sub-grouped vary with the size of the factory, nature of industry, and the extent of control necessary. The larger the subdivision, more effective is the control exercised, but too fine a classification into a very large number of standing order numbers involves increased clerical costs.

Each standing order number is identified by a code number or symbol. This may be done in a number of ways as follows :—

(i) *Serial numbering system* : Each type of expenditure is assigned a number in serial order as shown below :

S.O. No. 1	General shop labour
S.O. No. 2	Contractable shop stores
.....
S.O. No. 43	Idle time
.....
S.O. No. 52	Training of workers
.....
S.O. No. 140	Insurance

A group or block of numbers may be set apart to classify the expenses under a main or broad head. Thus, S.O. Nos. 61 to 70 may indicate maintenance expenses on different types of assets. A sub-number may indicate the department or cost centre concerned.

(ii) *Codes with a combination of numbers and alphabets* : The following list will illustrate the method. The alphabet denotes the main group ; the type of expenditure in that group is indicated by the numeral.

D1	Depreciation of plants
D2	Depreciation of tools
D3	Depreciation of fixtures
D4	Depreciation of buildings
D5	Depreciation of other assets

(iii) *Numerical codes* When accounting is mechanised, use of alphabets is restricted and numerals are used to indicate each type of expenditure. The particular method of classification adopted varies from concern to concern. The following extract from a Standing Order Number Manual is given to illustrate the method :—

Code	Particulars	Remark
111400100	Idle time , breakdown of machines	
111400200	Idle time , waiting for material	
114300100	Depreciation , plants	
114300200	Depreciation , buildings	
118900100	Salary , officers	
118900200	Salary , staff	
224100100	Repairs , electrical	Expenditure exceeding Rs 2,000 per item should be capitalised and should not be booked against these numbers
224100200	Repairs , furnace	
224100300	Repairs , building	
224100400	Repairs , plant and machinery	

The first digit of the code indicates whether the expenditure is fixed or variable. The next three digits stand for the main expenditure and the subsequent three for further subdivision. The last two digits are meant to indicate the code number of the department or cost centre which incurs the expenditure. For example, if Lathe Shop is given a code No 08, idle time in this shop due to breakdown of machines will be booked to Standing Order No 111400108.

Sources of Information for the Classification of Overhead Expenditure. Overhead expenses are collected and classified under the various Standing Order Numbers after obtaining information from different sources, as follows :—

- (i) *Direct from financial accounts* : A very large number of items may be taken directly from the ledgers and subsidiary documents in the financial accounts.
- (ii) *Estimates from financial accounts* : When financial accounts reveal payments made at regular but long intervals, equitable provisions to be made for each costing period are estimated. Examples are : rent paid at a time for the whole year, depreciation calculated for the whole year, and holiday payments (the number of holidays not being the same for each cost period).
- (iii) *Direct from cost accounts* : Various items are booked from the subsidiary cost documents. As for example, indirect labour is

obtained from wages abstract, maintenance material cost from materials analysis sheet, depreciation from depreciation schedule, and notional items and opportunity and imputed costs from subsidiary statements.

- (iv) *Estimates of liabilities or receipts* : Sometimes provision is required to be made in the cost accounts in anticipation of some cash outlay to be made or cash to be received in the future, such as wanting debits or credits from the head office, delayed electricity, telephone and other bills, outstanding income, etc.

The various documents used for the accumulation of overhead costs from the different sources are described later.

Importance of Distribution of Overhead Expenses. The problem of distributing overhead expenses to cost centres and cost units is the most important consideration in the operation of a cost accounting system. Direct labour and direct material costs are directly allocated to cost units (or to departments in case of processes) but expenses in the nature of indirect costs some of which are common costs and the amount of which is sometimes proportionately high, are absorbed indirectly on some suitable basis. The method adopted for the absorption must be scientific and it must be reasonably accurate because any mistakes in this regard may mislead the management to take incorrect decisions. Admittedly, the present trends towards rapid mechanisation with reduced manual labour and more complex plants, equipments, and processes, point to the increasing importance of overhead costs and the need for revising our old outlook on the treatment of such costs.

If the overhead expenditure is not fully absorbed, the costs of products and services would tend to be on the low side. Sales when compared with such low costs will, no doubt, reveal better apparent profit and the sales department will try to secure more orders in anticipation of higher profits. But the result may not be as expected since the hidden loss in the shape of unabsorbed overhead may drain away the profit. Further, if sale prices are fixed on the basis of costs, there will be a tendency to fix these at lower levels. On the contrary, if overhead is absorbed in excess of the amount incurred, the market may be lost due to higher selling price that would be quoted on the basis of higher costs of production.

Besides maintaining a balance between accuracy or precision of work desired and the cost and time factors involved, the accounting system for overhead should take into consideration the size of the factory, the nature of production, the importance given to cost ascertainment and cost control work, and the policy of the management. The system adopted should be simple and easy to operate.

Allocation and Apportionment of Overhead to Cost Centres (Departmentalisation of Overhead). The next step in the accounting and control of overhead, after completion of classification and collection, is to allocate and/or apportion the cost to cost centres. This is also known as *departmentalisation or primary distribution of overhead*.

In order to have efficient managerial control, a factory is organised administratively into a number of divisions or departments. Each department

denotes a particular activity of the concern so that definite responsibility or physical control is laid on individuals in charge, and the natural flow of materials and the sequence of operations from one department to another is maintained. There are three types of departments which we come across in a manufacturing organisation, viz. *Producing departments, Service departments, and Partly-producing departments*. The actual process of manufacturing takes place in a producing department, a test for which is that in such a department, some operation, either manual or machine, must be performed on any part of the materials which ultimately form a part of (or are converted into) the product. A service department renders a specific type or nature of service for the benefit of other departments and though not taking part in the actual operation of conversion of materials into products, service departments are essential for running the production activities of a concern. Types and examples of service departments and producing departments are given in Chapter 1. In some firms, there are a few departments, known as partly-producing or partly-servicing departments which not only render service to other departments but are also engaged in direct manufacturing activities. Such departments are actually service departments but are occasionally called upon to undertake direct production work.

The departmentalisation of overhead expenses is equally important in non-manufacturing business and non-profit organisations. For the purpose of cost control, a retail store may, for instance, be divided into a number of departments such as administration, purchasing, selling, distribution, sales promotion, building repairs, etc. Similar departmentalisation would be made of the expenses incurred in financial institutions, educational institutions, hotels, hospitals and nursing homes. The departmentalisation or grouping of the expenses in an organisation will depend upon its nature, administrative set up and the extent of cost control desired.

While the normal organisational divisions of a factory would usually fit in with the costing system—each department representing one cost centre for accounting and control of costs—it sometimes so happens that the departmental division is not suitable for cost purposes. A department organised from the administrative point of view may not be suitable from cost allocation point of view. In such a case, the departments may, for costing purposes, be further organised into cost centres. For example, one producing department may have two or three very distinct types of machines or it may undertake several different processes of manufacture. For the purpose of overhead accounting and control, such a department may be split up and thus, it may consist of two or three distinct cost centres. On the other hand, two or more departments may sometimes be combined for cost ascertainment purposes into one cost centre. Departments like canteen, hospital, and school may, for instance, be merged as one service cost centre termed as Welfare Department.

The factors to be taken into account in selecting departments/cost centres are

- (i) Similarity of operations, processes, machines, and equipments in a department.
- (ii) Location of operations and processes and the physical flow of the product or the materials through various departments.

- (iii) Division of responsibility for control of production, and incidence and control of cost.
- (iv) The optimum number of cost centres. (Too many cost centres make the cost accounting system detailed and more expensive ; too few cost centres do not provide complete cost information and make control ineffective.)

In the accounting and control of overhead costs, we are mainly concerned with impersonal cost centres so that each such cost centre is charged with its share of overhead costs for ultimate absorption in products or cost units. Some expenses may be directly linked with or traced to a particular department or cost centre as having been incurred for that cost centre. Examples of overhead costs that may be so allocated are maintenance and repairs expenses incurred in specific departments, indirect materials consumed in departments, and salaries, overtime, idle time, etc. of particular departments. There is another type of expenses such as the salary of the general manager, medical and canteen expenses, time keeping expenses, etc. which is incurred jointly for a number of departments or for the factory as a whole and cannot, therefore, be identified with any particular department or cost centre. Such items of common costs, termed as general overheads or omnibus expenses, are apportioned to various cost centres on equitable bases. Apportionment consists of the process of allocation of proportions of items of cost to the cost centres.

The distinction between *cost allocation* and *cost apportionment* is important. Although the purpose of both allocation and apportionment is identical, namely to identify or allot costs to cost centres or cost units, allocation deals with items as a whole whereas apportionment refers to the prorating of items of cost. Allocation is a direct process but apportionment may be made only indirectly and for which suitable bases are to be selected. Whether an item of expense can be allocated or apportioned does not depend upon the nature of the expenses but upon its relation with the cost centre or cost unit to which it is to be charged. For example, the expenditure on general repairs and maintenance pertaining to a department can be allocated to that department but it can only be apportioned to the various machines running in the department. Similarly, allocation of departmental overhead to products is not possible—it can only be absorbed on a suitable basis—unless there is only one product manufactured in the department. Joint costs incurred for process departments, or operations which result in the simultaneous production of more than one product can only be apportioned to the individual joint products on appropriate basis.

Departmentalisation of overhead is considered necessary for the following reasons :—

- (i) The services rendered by the various service cost centres in a concern are different and the nature of production in each producing centre is not uniform. Some products may require more hand labour, some others may be fabricated with the help of specialised machines of considerable value, while some may be processed by less costly machines. The products manufactured in cost centres where facilities of machines and other equipments are not utilized should not be loaded with overhead relating to machines, such as depreciation, power cost, and

machine repairs and maintenance. In order to ascertain costs correctly, expenses should be allocated or apportioned to the proper cost centres to which they belong.

- (ii) Departmentalisation serves the purpose of control over overhead costs. Effective control may be exercised by comparing departmental costs with budgets or past actuals and fixing responsibility on departmental foremen or managers.
- (iii) The management may find the costs of various service departments useful. This is of assistance in preparing estimates and quotations and for cost plus contracts for items which involve the services of the various cost centres.
- (iv) The basis of absorption may be different for individual cost centres, e.g. while machine hour rate may be suitable for some cost centres, direct labour hours or direct wages basis may be more appropriate for others.
- (v) In process costing, many of the departments are identical with the processes. The need for assignment of overhead costs to such departments is obvious.
- (vi) Unless overhead is departmentalised, the cost of work-in-progress may not be correctly worked out. For example, a product in a partly completed stage may still be required to pass through one or more departments before it is completed but if overhead is not departmentalised, the cost of the work-in-progress will be loaded with a part of the overhead of all the departments including those in which the product is yet to be processed.

Apportionment of Service Cost Centre Costs to Producing Cost Centres (Secondary Distribution of Overhead Cost). As jobs or products pass through producing cost centres only, the entire overhead costs should ultimately be borne by such cost centres in order that the legitimate share thereof may be charged to each cost unit. The costs pertaining to service cost centres are, therefore, apportioned suitably to the producing cost centres. The base selected for apportionment varies for each service cost centre depending upon the nature and extent of the service it renders to the other departments or cost centres. A list of the bases commonly used is given below :

<i>Base</i>	<i>Expenditure for which suitable (For Primary distribution)</i>	<i>Department for which suitable (For Secondary distribution)</i>
Direct labour hours	Most of the overhead expenses	Maintenance and Repair Shops
Machine hours		Planning and Progress
Direct labour wages		Tool Room
Number of workers		Canteen and Welfare
Number of employees		Hospital and Dispensary
		Personnel Department
		Time keeping
Capital value	Depreciation and insurance of buildings and equipments	Maintenance and Repair Shops (including Building Maintenance) Fire Protection

<i>Base</i>	<i>Expenditure for which suitable (For Primary distribution)</i>	<i>Department for which suitable (For Secondary distribution)</i>
Floor area	Heating and lighting	Power House (electric light cost)
Cubic content	Building maintenance	
Wattage	Electric power and lighting	Power House (electric power cost)
Horse Power	Motive power expenses	
Horse power \times machine hours		
Number of electric points		
Weight or value of materials	Store keeping expenses	Stores Department
Number of materials requisitions	Internal transport	
Value of materials consumed		
Crane hours	Transport service expenses	Transport Department
Truck hours		
Truck mileage		
Truck tonnage		
Truck tonne-hours		
Tonnage handled		
Number of packages		

The particular base adopted for apportioning service department cost will depend upon the practicability, equitableness, and reliability of the method selected as well as the cost involved in the accounting work.

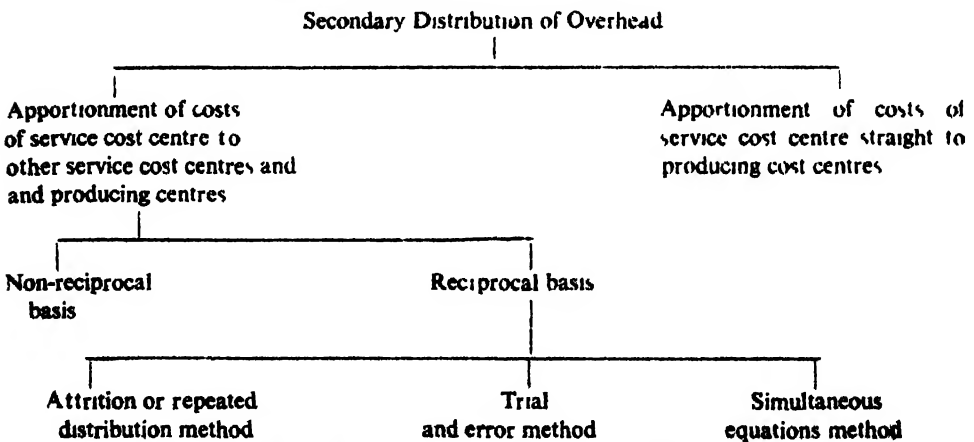
Several methods are in use for the apportionment of overheads costs, such as:

- (i) *According to the service rendered or the use made of or benefit received from the service*: This method discussed in the preceding paragraph is based on the concept that the share of overhead cost borne by a cost centre or cost unit should be in proportion to or according to the extent of service received by it. The cost of maintenance shop, for instance, may be apportioned to the producing cost centres on the basis of machine hours or capital value of the machines; the more the number or value of machines or the number of hours worked in a particular centre, the higher should be the share of costs of maintenance shop borne by it. The method is considered rational but needs elaborate accounting for its operation.
- (ii) *Regression analysis method*: We have seen that the coefficient of determination, r^2 expresses the co-relationship between two variables; higher the value of r^2 , closer is the relationship. The method lies in collecting past data in respect of the item of cost to be apportioned and the corresponding figures for a number of proposed bases and computing the values of r^2 related to each base. The base which gives the highest value of r^2 is selected. In the illustration given on Page 196, the higher value of r^2 , i.e. 0.9293 indicates that machine hour in this case is a more suitable base for apportionment of power costs than direct labour hours.
- (iii) *By an analysis of the existing conditions*: This method is mainly arbitrary and is used when it is difficult to select a suitable base for apportionment.

A survey is made of the various factors involved and the share of the overhead costs to be borne by each cost centre is determined. The salary of the works manager may, for example, be apportioned on the basis of an assessment of the time and attention which he gives to the various cost centres. The cost of lighting, where not metered, may similarly be apportioned on a survey of the number and wattage of light points and the hours of use in each cost centre.

- (iv) *On the basis of ability to pay or bear* : Under this method, a higher share is apportioned to those cost centres or cost units which contribute more towards the profits of the concern. General office expenses may be apportioned to the producing cost centres on the basis of the net sales or profits of the output of the various cost centres. Obviously, this method is not equitable and is useless for the measurement of the efficiency of individual cost centres.
- (v) *Efficiency or incentive method* : The apportionment is made on the basis of budgets or standards set for each cost centre. As a fixed amount of overhead cost is apportioned to a cost centre based upon its budgeted volume, the efficiency of the centre is reflected through a reduction in the cost per unit when the budgeted volume is surpassed or the actual cost of the cost centre is below the budget.

The manner in which the cost of a service cost centre may be apportioned to producing cost centres (the process is also known as secondary distribution of overhead costs) is summarised below :



Apportionment on Non-Reciprocal Basis. In the non-reciprocal method, the service cost centres are arranged on a distribution statement or analysis sheet in the descending order of their serviceability. The most serviceable department, i.e. the department which renders significant service to most of the other service cost centres or putting it the other way, the department which receives the least service, is taken up first. The serviceable department next in the descending order, comes thereafter and so on till the least serviceable department is placed last in the analysis statement. In some concerns, the centres are arranged in the order of the amount of expenditure incurred, the centre with the largest figure coming first. The cost of the first service cost centre is apportioned on a suitable basis to the other service and producing cost centres. The first cost centre is then 'closed'

and the cost of the second cost centre is apportioned to the remaining cost centres. The process is repeated till the costs of all the service cost centres have been apportioned. It would be seen that the cost of the service cost centre appearing last in the statement can be apportioned to producing cost centres only. The method (also known as the *step method*) is illustrated in the example given below :

EXAMPLE 4.2.

A company operates a factory whose budgeted cost of production for a year is as follows :-

	Rs.	Rs.	Rs.	Rs.
Production cost :				
Direct wages		1,00,000		
Direct material cost		1,20,000		
		-----	2,20,000	
Indirect materials				
No. 1 shop	4,000			
No. 2 shop	6,000			
No. 3 shop	2,000			
Tool room	1,200			
Stores	1,600			
Clerical service department	600			
	-----	15,400		
Supervision and indirect wages :				
No. 1 shop	4,200			
No. 2 shop	5,800			
No. 3 shop	5,400			
Tool room	3,700			
Stores	1,500			
Clerical service department	2,200			
	-----	22,800		
Rent and rates		10,000		
Insurance		2,000		
Depreciation (15%)		30,000		
Power		9,000		
Light and heat		4,000		
		-----	93,200	3,13,200

The following operating information is also available :

Department	Area (Sq. Metre)	Book value of machinery & equipment	Effective H.P.	Productive Capacity		
				Direct Labour		
				Hours	Cost	Machine Hours
		Rs.			Rs.	
Productive :						
No. 1 shop	1,000	50,000	50	1,50,000	45,000	80,000
No. 2 shop	750	90,000	40	1,50,000	30,000	1,20,000
No. 3 shop	1,500	20,000		1,00,000	25,000	
Service :						
Tool room	500	30,000	10		25,000	
Stores	750	5,000				
Clerical Service	500	5,000				
	5,000	Rs.2,00,000				

You are required to :

Prepare an overhead analysis sheet for the departments of the factory for the year showing clearly the basis of apportionment. (I. C. W. A., Inter—Adapted)

ANSWER :

Expenses	Total	Basis of allocation	Clerical service	Stores	Tool room	No 1 shop	No 2 shop	No. 3 shop
	Rs		Rs	Rs	Rs	Rs	Rs	Rs
Indirect materials	15,400	Direct	600	1,600	1,200	4,000	6,000	2,000
Supervision and direct wages	22,800	Direct	2,200	1,500	3,700	4,200	5,800	5,400
Rent and Rates	10,000	Area	1,000	1,500	1,000	2,000	1,500	3,000
Insurance	2,000	Book value of machine	50	50	300	500	900	200
Depreciation	30,000	15% of book value	750	750	4,500	7,500	13,500	3,000
Power	9,000	H P			900	4,500	3,600	-
Light & heat	4,000	Area	400	600	400	800	600	1,200
	<u>93,200</u>		<u>5,000</u>	<u>6,000</u>	<u>12,000</u>	<u>23,500</u>	<u>31,900</u>	<u>14,800</u>

Service Department
Clerical Service

Direct labour cost

Cr 5,000

1,000 1,800 1,200 1,000

Stores

Indirect material value

Cr 6,000

545 1,818 2,727 910

Tool Room

Machine

Cr 13,545

5,418 8,127

32,536 43,954 16,710

In the other method of apportionment of service cost centre expenses (also known as the direct method), the service rendered by one service department to another is ignored and the service department costs are apportioned direct to the producing cost centres. On this basis, the apportionment of the costs shown in the above example would be as follows :

Total	Clerical Service	Stores	Tool Room	No 1 shop	No 2 shop	No 3 shop	
Rs.	Rs.	Rs	Rs.	Rs	Rs	Rs	
93,200	5,000	6,000	12,000	23,500	31,900	14,800	
	<u>Cr 5,000</u>			2,250	1,500	1,250	Direct labour cost
		Cr 6,000		2,000	3,000	1,000	Indirect materials handled
			<u>Cr 12,000</u>	4,800	7,200		Machine hours
				<u>Rs 32,550</u>	<u>Rs 43,600</u>	<u>Rs. 17,050</u>	<u>Rs. 93,200</u>

The direct method of apportionment to producing cost centres has the following *advantages* :—

- It is a simple method involving less clerical work.
- Service departments need not be arranged in any particular order.
- The problem of inter-departmental apportionment does not arise,

i.e. there is no question of reciprocal services rendered by two or more services cost centres.

The *demerits* of this method are :

- (a) Correct cost of each service cost centre inclusive of the share of expenses of other service cost centres is not available to the management.
- (b) In the absence of allocation and apportionment of costs to service cost centres, effective control of costs of these centres is not possible.

In the illustrations of apportionment given above, partly-producing departments do not appear. Such a department is actually a combination of two cost centres, one of which is a service cost centre and the other a producing cost centre. For example, a Tool Room which repairs and maintains tools as well as manufactures them may be taken as a partly-producing department. Overhead costs pertaining to a partly-producing department are first, apportioned to these two cost centres, viz. service and producing cost centres on an appropriate basis. The apportionment is usually made prorata to the number (or the wages) of the direct and indirect workers in the department. Both the cost centres are then suitably placed in the distribution statement ; one appears as a service cost centre and the other as a producing cost centre, and subsequent apportionments are made in the normal manner discussed above.

Reciprocal Costs Apportionment. As stated previously, one of the shortcomings of the method of apportionment of service cost centre costs to other service cost centres is the problem of inter-locking departments, i.e. when two service cost centres render mutual service, the services of only one of the two centres can be accounted for, the other being ignored. For example, in a distribution statement, cost centre no. 1 standing first, renders service to say, service centres nos. 3, 4 and 5, which appear in the 3rd, 4th and 5th places respectively in the statement. It may so happen that centre no. 4 also renders some service to centre no. 1 in which case the latter should also bear a share of cost of centre no. 4. This cannot be done as centre no. 1 has already been 'closed' in the distribution statement.

Three methods are in use for the apportionment of costs on a reciprocal basis. These are discussed below :

- (i) *Continued distribution or Attrition method* : In this method, distribution of share is made also to service cost centres already 'closed' in the distribution chart. The distribution process is repetitive ; a 'closed' cost centre is 'opened' again and again till the amount to be distributed to it is found to be insignificant. Though suitable for two or three reciprocal service centres, the method becomes complicated and time consuming where a large number of such centres is involved.

Let us assume that there are only two service cost centres and three producing cost centres and the extent of service rendered by the former are as follows :—

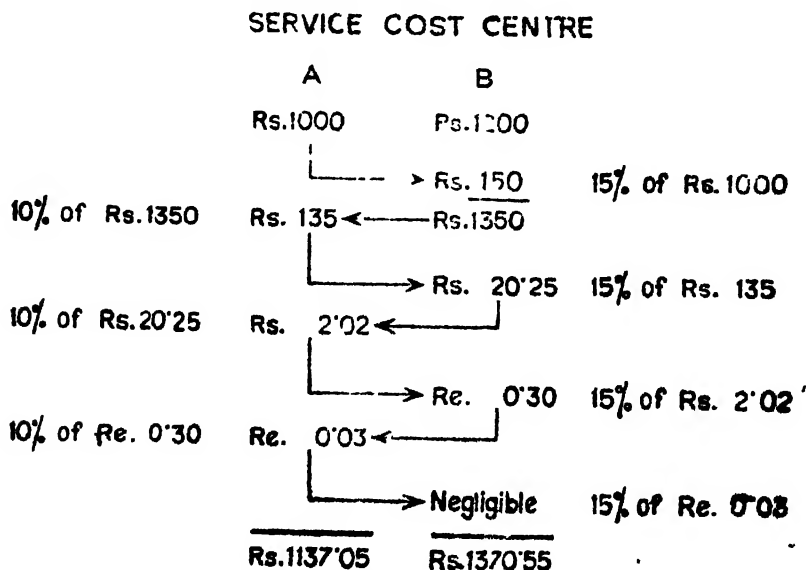
Service Cost Centre A (Rs. 1,000) :	15% to service cost centre B and 25%, 10%, and 50% to producing cost centres X, Y, and Z respectively.
Service Cost Centre B (Rs. 1,200) :	10% to service cost centre A and 20%, 40% and 30% to producing cost centres X, Y, and Z respectively.

The distribution chart is shown overleaf.

		COST CENTRES					
Total	A	B	X	Y	Z		
Rs. 9,700	Rs 1,000	Rs 1,200	Rs 4,000	Rs 2,000	Rs 1,500		
A	(1,000)(1)	150	250	100	500	(1)	Apportionment of cost of A
B	135	(1,350)(2)	270	540	405	(2)	Apportionment of cost of B plus share from A
A	(135)(3)	20.25	33.75	13.50	67.50	(3)	Apportionment of fresh share in A received from B
B	2.02	(20.25)(4)	4.05	8.10	6.08	(4)	Apportionment of fresh share in B from A
A	(2.02)(5)	.30	.51	20	1.01		Similarly for (5), (6) and (7) The process is continued till the balance becomes small when it is apportioned direct to the producing cost centres
B	.03	(.30)(6)	.06	.12	.09		
Rounding off			.01	-	.02		
			4,558.38	2,661.92	2,479.70		Rs 9,700

The method can be similarly applied in cases where more than two reciprocal service centres are involved but with a large number of such centres, the calculations would be complicated and time consuming.

(ii) *Trial and error method* : The method is suitable where two or three interlocked service cost centres are involved. This is illustrated below :



The cost of centre A is first apportioned to centre B ; the cost of centre B plus the share from centre A is then apportioned back to centre A. The amount so apportioned to A is again apportioned to B and the process is repeated till the amount to be apportioned becomes negligible.

The two amounts, viz. Rs. 1,137.05 and Rs. 1,370.55 are subsequently apportioned to the producing centres X, Y, and Z.

(iii) *Method of simultaneous equations* : The same results as in the previous two methods may be obtained mathematically with the help of simultaneous equations. The equations will be :

$$A = \text{Rs. } 1,000 + 10\% B ; \text{ or } A = 1,000 + \frac{10B}{100} \quad (i)$$

$$B = \text{Rs. } 1,200 + 15\% A , \text{ or } B = 1,200 + \frac{15A}{100} \quad (ii)$$

On solving the above equations, we get,

$$A = \text{Rs. } 1,137.05, \text{ and}$$

$$B = \text{Rs. } 1,370.55$$

Alternatively, if X_1 and X_2 be the total costs to be associated with cost centres A and B respectively,

$$X_1 = 0.10X_1 + 1,000 \quad (i)$$

$$X_2 = 0.15X_1 + 1,200 \quad (ii)$$

$$\text{Whereby, } X_1 = \text{Rs. } 1,137.05$$

$$X_2 = \text{Rs. } 1,370.55$$

The method is illustrated further in the following example : —

EXAMPLE 4.3.

A factory comprises two production Departments and three service Departments. For the month of July, direct departmental expenses were as follows :—

Production Department

A -- Rs. 85,000

B -- Rs. 70,000

Service Department

Power House Rs. 47,350

Store Rs. 15,000

Repair Shop Rs. 60,500

The expenses of service departments are distributed on a percentage basis as under :

Power House : 25% to Repair Shop, 25% to Deptt. A and 50% to Deptt. B

Store : 10% to Power House, 20% to Repair shop, 30% to Deptt. A and 40% to Deptt. B

Repair Shop : 20% to Power House, 30% to Deptt. A and 50% to Deptt. B

Prepare a statement showing the distribution of service departmental expenses to production departments using simultaneous equations method. (C. U., M.Com.)

ANSWER :

As no reciprocal service is involved in the case of Store, the expense of this department is apportioned first. The adjusted expenses of Power House and Repair Shop which render mutual services are then worked out using simultaneous equations method and the distribution is made as follows :—

Store	Power House	Repair Shop	Department A	Department B	Total
Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
15,000	47,350	60,500	85,000	70,000	2,77,850
--	1,500	3,000	4,500	6,000	
	(10%)	(20%)	(30%)	(40%)	
	<hr/>	<hr/>			
	48,850	63,500			
	<hr/>	<hr/>			
	48,595*	63,755*	16,200*	32,395*	
	<hr/>	<hr/>	23,908*	39,847*	
			<hr/>	<hr/>	
			1,29,608	1,48,242	2,77,850
			<hr/>	<hr/>	<hr/>

*The figures are calculated as explained below :

If P denotes Power House and R, Repair Shop, the equations will be,

$$P = 48,850 + 1/5 R, \text{ and } R = 63,500 + 1/4 P$$

$$P = 64,789 \text{ and } R = 79,695$$

The same result will be obtained by applying the formula stated earlier. Thus if x_1 , x_2 and x_3 be

the costs to be associated with Store Power House, and Repair Shop respectively, the following equations will be set up

$$\begin{aligned} x_1 &= 0x_2 + 0x_3 + 15,000 \\ -0.1x_1 &+ x_2 = 0.2x_3 + 47,350 \\ -0.2x_1 &+ 0.25x_2 + x_3 = 60,500 \end{aligned}$$

Solving the equations we get,

$$x_1 = 15,000, x_2 = 47,359, \text{ and } x_3 = 79,695$$

The expenses now distributed are

Power House

To Deptt A	25% of Rs 64,789	Rs 16,200
To Deptt B	50% of Rs 64,789 -	Rs 32,395
		<hr/> Rs 48,595

Repair Shop

To Deptt A	30% of Rs 79,695	Rs 23,908
To Deptt B	50% of Rs 79,695	Rs 39,847
		<hr/> Rs 63,755

It will be seen that the methods of adjustment of reciprocal service costs described above, require a large number of mathematical calculations. The problem becomes further complicated if the number of service cost centres is large, in which case there would be as many equations as the number of centres involved. Help of the computer may be taken to solve these equations but unless accuracy is of paramount importance, complex adjustments on reciprocal basis should be treated merely as academic exercises, not to be used in practice.

Another example illustrating the different methods of apportioning service department costs to producing departments is given below :

EXAMPLE 4.4

Defex company manufactures a number of components for household electrical gadgets. It has two service departments S_1 and S_2 and two production departments P_1 and P_2 . The estimated overhead costs for a period and interdepartmental relationship matrix are given below.

Service provided by	Service provided to				Total
	S_1	S_2	P_1	P_2	
S_1		10%	40%	50%	
S_2	20%	—	50%	30%	
Total estimated overhead costs	Rs 9,000	Rs 4,000	Rs 3,500	Rs 3,000	Rs 19,500

You are required to calculate the overhead costs for P_1 and P_2 using

- Direct allocation method,
- Step method of allocation, (a) allocating S_1 costs first and (b) allocating S_2 costs first,
- Reciprocal method of allocation.

ANSWER :

(i) *Direct allocation method*

	S_1	S_2	P_1	P_2	
	Rs	Rs	Rs	Rs	
Total cost	9,000	4,000	3,500	3,000	
S_1	(9,000)		4,000	3,000	(Basis $\frac{40\%}{90\%}$ $\frac{50\%}{90\%}$ or 4 : 5)
S_2	—	(4,000)	2,500	1,500	(Basis 5 : 3)
			<hr/> Rs 10,000	<hr/> Rs 9,500	
					Total Rs. 19,500

(ii) (a) *Step method of allocation (Allocating S_1 cost first)*

	S_1 Rs.	S_2 Rs.	P_1 Rs.	P_2 Rs.	
Total cost	9,000	4,000	3,500	3,000	
S_1	(9,000)	900	3,600	4,500	
		(10%)	(40%)	(50%)	
S_2	—	(4,900)	3,062	1,838	(Basis $\frac{50\%}{80\%} : \frac{30\%}{80\%}$ or 5 : 3)
					Total
			Rs. 10,162	Rs. 9,338	Rs. 19,500

(ii) (b) *Step method of allocation (Allocating S_2 cost first)*

	S_1 Rs.	S_2 Rs.	P_1 Rs.	P_2 Rs.	
Total cost	9,000	4,000	3,500	3,000	
S_1	800	(4,000)	2,000	1,200	
	(20%)		(50%)	(30%)	
S_2	(9,800)	—	4,356	5,444	(Basis 4 : 5)
					Total
			Rs. 9,856	Rs. 9,644	Rs. 19,500

(iii) *Reciprocal method*

Equations for total cost are .

$$S_1 = 9,000 + .2S_2 \text{ and}$$

$$S_2 = 4,000 + .1S_1$$

Solving the equations, $S_1 = \text{Rs. } 10,000$ and $S_2 = \text{Rs. } 5,000$

The reciprocal allocation is as follows :—

	S_1 Rs.	S_2 Rs.	P_1 Rs.	P_2 Rs.	
Total cost	9,000	4,000	3,500	3,000	
S_1	(10,000)	1,000	4,000	5,000	
S_2	1,000	(5,000)	2,500	1,500	
	0	0	Rs. 10,000	Rs. 9,500	Total
					Rs. 19,500

Treatment of Specific Items of Manufacturing Overhead. The problems involved in the accounting and control of some specific items of manufacturing overhead expenses will now be dealt with. The accounting of a particular item of expenditure depends largely upon its size and its nature. Other factors like nature of the industry, methods of production, size of the factory, and management policy do also count and are responsible for the varied practice in different undertakings.

However paradoxical it may appear, the general tendency is to allocate an item of expenditure direct to outturn or production orders as far as practicable. If this is not possible or not convenient because of the extra clerical labour involved in the analysis, the expenditure is treated as an item of manufacturing, administration, selling, or distribution overhead cost, as the case may be. If it is possible to identify an expense item with a specific department or cost centre or cost unit, it is allocated to the cost centre etc. ; otherwise, suitable apportionment is made. Heavy expenditure on new project, expansion, etc. which is not in the nature of capital costs, but which at the same time cannot be 'borne by normal traffic' is usually deferred and carried over to the subsequent accounting periods for

recovery in the cost of future production. Expenditure which is not related to the normal activities of an undertaking, e.g. abnormal wastes, heavy losses or windfall incomes, theft, pilferage, etc. should not find place in the outturn costs. Such items are accounted for by transfer to Profit and Loss Account or Costing Profit and Loss Account, as the case may be.

Items of expenses for the accounting of which opinions differ, e.g. interest, administration overhead, certain fringe benefits, research and development costs, depreciation on replacement cost basis, and taxes may or may not be charged in costs depending upon the particular policy adopted. Inclusion of such expenses in costs is a matter of argument and opinion. These will be discussed later.

Canteen Expenses. Provision of canteens to cater for the needs of the workers and other employees is a welfare measure, the cost of which is borne by the employers. The canteen may be run on a 'no profit no loss' basis in which case the question of any expenditure being incurred does not arise. Where canteens are subsidised, the expenditure involved is treated as overhead cost. A standing order number or separate standing order numbers for each of the workers' canteen, staff lunch room, officers' lunch room etc. are allotted for charging the canteen expenses. Receipts are also credited to the same standing order numbers and the net cost is apportioned to the producing cost centres on the basis of the total wages or the number of men employed. Apportionment may also be made on the basis of number of employees served or the number of meals served for each cost centre. Alternatively, canteen expenses may be merged with the Welfare Department costs.

Compensatory Payments to Workers. Treatment of such payments depends on the particular type of compensation paid to the employees. If this is a regular payment, such as gratuity paid to workers on retirement or termination of service, it is treated as an item of overhead. Normally, compensatory payments under the Workmen's Compensation Act are not regular and payments vary from period to period, depending upon the frequency of accidents, breakdown of machines, length of service, etc. Payments should be estimated and proportionate amount charged in each period on a uniform basis.

Dearness Allowance. Dearness allowance is paid to a worker in addition to his basic wages to cover the increased cost of living. Sometimes house allowance is paid on a suitable scale wherever it is not possible to provide a worker with factory quarters. For extra arduous nature of work or for natural hardship suffered in the locality, some compensatory allowance may also be paid. The idea underlying all such payments is to compensate the worker without changing the basic pay structure.

One method of treatment of payments on account of dearness allowance etc. is to charge these direct to the work on which a worker is engaged, i.e. to the production or outturn orders or to standing order numbers in case of indirect workers, by inflating the basic wage rate. This requires locating the actual payment made to each worker and booking the expenditure on the respective labour cards. As this method is by and large complicated and time consuming, a practice which is quite common is to consider these allowances as overhead costs. Separate standing order numbers are allotted for booking each type of allowance. The

allowances are combined with other overhead expenses of a cost centre and absorbed in cost units in the normal manner. A variation of this method is to have a separate rate for absorption of dearness etc. allowances in labour costs. For this purpose, the rate, which may be either historical or predetermined as the case may be, is computed as a percentage of the dearness allowance to the basic wages of a cost centre in a period. Initially, only the basic wages are booked on the labour cards and the allowance percentage is applied to arrive at the total labour cost of a production order or standing order number. The rate is applied to direct as well as indirect wages. Any under- or over-absorption at the year-end is either reallocated or booked to general overheads.

Depreciation. A fixed asset such as a plant or a machinery has a life span during which it renders service of the nature it is intended to give and on the expiry of which, the asset has either no value or has only a small value as scrap. The life of an asset is reduced by extensive usage but may be enhanced by efficient maintenance. During the period of life of the asset, its value is thus gradually reduced till it reaches nil or a very small figure; this reduction in value is called depreciation. Depreciation is defined as the diminution in the value of a fixed asset due to use and/or lapse of time. It will be seen from the definition that depreciation of an asset takes place due to fair wear and tear on account of two factors, viz. usage and lapse of time, both of which may operate simultaneously. The principle of usage recognizes the fact that more the use to which an asset is put to, the larger will be its depreciation. Under this concept, an idle asset should not depreciate but when it works overtime or in two or more shifts, the depreciation may be doubled or trebled. The principle of time factor stipulates that depreciation occurs with the passage of time, the extent of use of the asset not being a significant consideration. The methods of calculation of rates of depreciation, which have been described in the following paragraphs, take one or the other, or both the factors of usage and time into consideration.

Depreciation should be distinguished from *obsolescence*. The latter is the loss in the value of an asset due to its supersession at a date earlier than that foreseen. Obsolescence arises when, before the expiry of its normal life, an asset needs replacement by a new and improved asset. Obsolescence may also arise when an asset becomes redundant for the current needs because of the discontinuance of a product, no alternative work for the asset being available. Sometimes due to change in the design and nature of the product or in the technology, the existing asset is not adequate to meet the needs of production and so it becomes obsolete. An asset may also have to be prematurely discarded if its performance is not up to the standard required to cope with increasing competition in the market. It should be noted that while only a fixed asset can depreciate, obsolescence may occur in respect of the other assets like materials and work-in-progress.

Obsolescence is accounted for by one of the following methods :—

- (i) If obsolescence can be foreseen and predicted, the rate of depreciation should include an element to take into account the obsolescence factor. For example, if it can be estimated that a machine costing Rs. 20,000 and having a salvage value of Rs. 500 and a serviceable life of 8 years, is likely to be outdated in 5 years' time only, due to, say, change in

technology, the annual depreciation to cover obsolescence will be $\frac{\text{Rs. } 20,000 - \text{Rs. } 500}{5} - \text{Rs. } 3,900$ as against the usual depreciation of

Rs. 2,437.5 (i.e. $\frac{\text{Rs. } 20,000 - \text{Rs. } 500}{8}$) per year.

- (ii) Depreciation is calculated at usual rates but when the asset becomes obsolete (or is discarded or retired prematurely for any reason), the resulting loss is written off from the profits. The write off may be made in the year in which the obsolescence occurs or it may be spread over a number of future years so that the charge to profit in a particular year may not be heavy. The loss to be written off will be represented by the depreciated book value of the asset on the date it is discarded less realisable value, if any.
- (iii) A reserve fund known as Obsolescence Reserve Account is credited every year. Whenever an asset is discarded due to obsolescence, the residual book value of the asset less its realisable value is debited to the Obsolescence Reserve Account.

In the financial accounts, depreciation is provided against profits for the purpose of replacement of a fixed asset, when need arises. Procurement of a fixed asset requires large capital outlay and it may not always be possible to raise fresh capital for meeting it. If depreciation is charged on an asset and a sum is set aside from the profits and invested, an amount equivalent to the price of the new asset may be available by the time the existing asset has served its full life and replacement of the asset should not cause any serious drain upon the current resources of the undertaking.

In the cost accounts, the charge for depreciation is taken as the cost of utilizing the fixed assets for the purpose of production. This would make costs comparable where production is carried out in a business both by owned and hired machines. In concerns where selling price is directly related to costs, e.g. in the case of cost-plus contracts, the necessity for charging depreciation to costs is obvious.

The amount of depreciation for a period for a department (or for the entire factory as a whole, if blanket overhead rates are in use) is booked to the standing order numbers specifically allocated for the purpose, separate standing order numbers, with suitable sub-numbers to indicate code number of the Section or Department where the asset is located, are allotted for booking depreciation for the various types of assets like plant and machinery, buildings, etc. If predetermined overhead rates are in use, depreciation should be estimated in advance, i.e. budgeted in the same manner as budgets are set for other items of overhead costs.

In most cases depreciation can be directly allocated to the various departments or cost centres concerned. Otherwise, depreciation on buildings may be apportioned on the basis of value, floor space, or cubic capacity of the buildings in each department and depreciation on plant and machinery and vehicles may be apportioned on the basis of the written down values of the assets in each cost centre.

The amount of depreciation charged in the cost accounts may be different from that charged in the financial (profit and loss) account. Further, while depreciation is always charged in the cost accounts, it may not sometimes be charged at all in the financial accounts. It may also be noted that the depreciation allowed for income tax purposes may be different from that charged in the cost or financial accounts.

There are several methods of calculating depreciation for the purpose of charging to costs. These methods are based on the following principles :—

- (a) Time factor.
- (b) Usage function.
- (c) Both time and usage factors.
- (d) Depreciation should also include an element for maintenance cost.
- (e) Besides providing for normal wear and tear, depreciation should also include an element of interest. This is based on the principle of opportunity costs, viz. that but for the investment in the asset, the amount would have earned revenue if employed otherwise.

The methods of calculation of depreciation are discussed in the following paragraphs. The particular method selected for depreciating an asset in an undertaking will depend upon the nature of the asset and the use to which it is put to.

A. *Methods of calculation of depreciation based on time factor*

(i) *Straight line method.* This method provides for depreciation by means of equal periodic charges over the assumed life of the asset. The life of the asset and its residual value at the end of the stipulated life are estimated and depreciation is calculated in the manner given below :

Cost of procurement of asset = Rs. 20,000 (*V*)

Estimated life = 15 years (*n*)

Salvage value, i.e. residual value of asset after 15 years = Rs. 500 (*s*)

$$\text{Annual amount of depreciation} = \frac{V - s}{n} = \frac{\text{Rs. } 20,000 - \text{Rs. } 500}{15} = \text{Rs. } 1,300$$

$$\text{Annual rate of depreciation} = \frac{\text{Rs. } 1,300}{\text{Rs. } 20,000} \times 100 = 6.5\%$$

The method is simple and is applicable to all types of assets. It makes a uniform charge to the accounts every year so that comparable costs are made available. As it is possible to estimate depreciation charges in advance, this method is suitable for establishing standards and budgets. Subsequent additions to the original value, however, create complications. Towards the later period of the life of an asset, its efficiency declines while maintenance cost rises. But as the amount of depreciation per period is a constant amount, the sum total of depreciation and maintenance and repair costs which are charged to the cost of production, increases progressively.

(ii) *Reducing Balance (or Diminishing Balance) Method.* In this method, depreciation is provided by means of periodic charges calculated at a constant proportion of the balance of the value of asset, after deducting the amounts previously provided. As in the straight line method, the life and residual value of

the asset are estimated and the rate of depreciation is calculated by means of a mathematical formula, as shown below :

With the data assumed for illustrating the foregoing method,

$$\text{Depreciation} = 1 - \sqrt[n]{\frac{s}{v}} = 1 - \sqrt[15]{\frac{500}{20,000}} = 0.218 \text{ or } 21.8\% \text{ per annum}$$

(It will be seen that the rate of depreciation is higher than in the straight line method and that the residual value of an asset can never be nil.)

As the rate of depreciation is charged on the reduced balance at the end of each accounting period, the amount of charge under the reducing balance method is gradually reduced so that towards the end of the life of the asset, when its efficiency usually decreases and the maintenance cost increases, less depreciation is charged. An assumption is that the aggregate of depreciation and maintenance costs charged to cost of production, in each period, would tend to be more or less uniform. Further, an earlier heavy charge has the effect of risk minimisation by lessening the impact of any probable loss due to setting in of obsolescence. The method is sought to be justified on the ground that an asset is not uniformly efficient in performance throughout its life, and so it is better to recover a major portion of its cost during the initial years when the rate of production is high. The calculations in this method are, however, slightly complicated compared to the straight line method, and the high depreciation charge in the first few years adds to the higher costs due to teething troubles in production experienced in the early years of the asset's life. If the asset has no residual or salvage value, the reducing balance method would not be suitable.

Mention may be made of a variant of the reducing balance method known as the *double reducing balance method* in which depreciation rate is taken as twice the straight line rate and is applied to the reducing balances. For the asset in the foregoing examples, the rate of depreciation under this method will be $6.5\% \times 2 = 13\%$ which will be applied to the diminishing balance every year.

(iii) *Sum of the Digits Method*. This method provides for depreciation by means of differing periodic rates computed according to the following formula. If 'n' be the estimated life of the asset, the rate for each period is calculated as a fraction in which the denominator is always the sum of the series, 1, 2, 3,n, and the numerator for the first period is 'n', for the second period n-1, and so on. The depreciation per period is unequal and is higher in the early stage of the life of the asset. The method is illustrated below :

Life of the asset : 15 years	
Denominator : 1 + 2 + 3 + 15 = 120	
Depreciation :	
1st year	$\frac{15}{120} \times (\text{Rs. } 20,000 - \text{Rs. } 500) = \text{Rs. } 2,437.50$
2nd year	$\frac{14}{120} \times (\text{Rs. } 20,000 - \text{Rs. } 500) = \text{Rs. } 2,275.00$
3rd year	$\frac{13}{120} \times (\text{Rs. } 20,000 - \text{Rs. } 500) = \text{Rs. } 2,112.50$
.....	
15th year	$\frac{1}{120} \times (\text{Rs. } 20,000 - \text{Rs. } 500) = \text{Rs. } 162.50$
Total depreciation = Rs. 19,500	

This method is similar to the reducing balance method to the extent that the amount of depreciation goes on decreasing with the age of the asset. Comparison of depreciation costs under the above three methods is illustrated in Fig. 4.7.

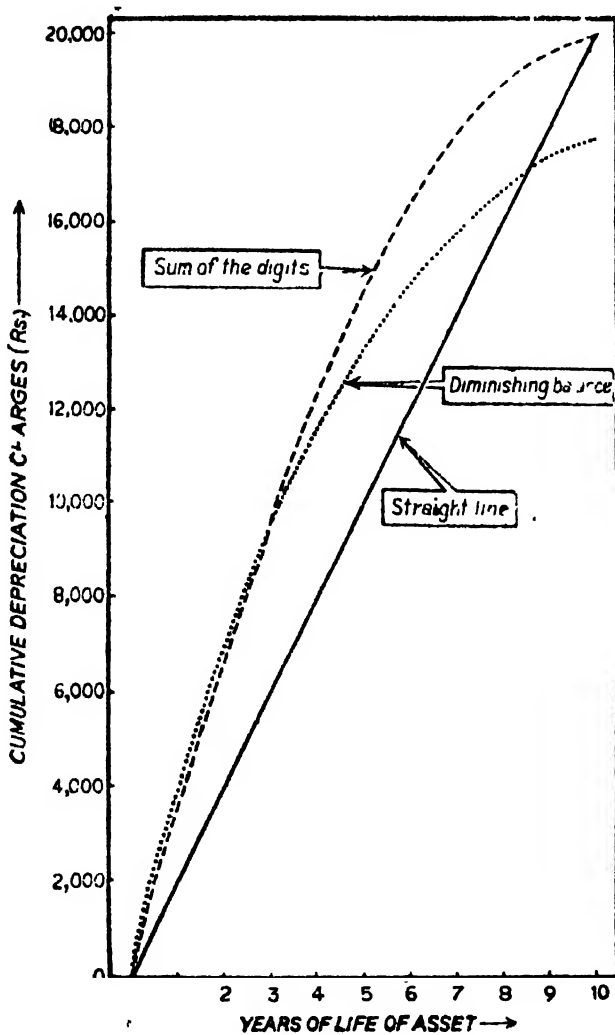


Fig 4.7. Comparative methods of calculating depreciation

B: Methods based on usage. Under methods based on usage, the time factor, i.e. the lapse of time is ignored and depreciation is a variable overhead expenditure. It should be noted that if there is no production from an asset in a period, depreciation cannot be calculated on usage basis, and a charge can be made only on the basis of time factor.

(i) **Production unit Method.** A fixed rate of depreciation per unit of production is obtained by dividing the value of the asset (V) less its salvage value (s) by the estimated units to be produced during its life period. The physical units of production (p) during the life span of the asset are assessed and depreciation is calculated as below :

$$\text{Rate of depreciation per unit of production} = \frac{V-s}{P} = \frac{\text{Rs. } 20,000 - \text{Rs. } 500}{19,500} = \text{Rs. } 1.00$$

(Assuming $p = 19,500$ units and other data as in the foregoing examples.)

Note : While calculating depreciation rates for motor vehicles under this method, the distance (kilometres) run is taken as the production unit.

This method does not take the time factor into account, and is applicable in case of plant and machinery directly engaged in production and for wasting assets like quarries, mines, oil extraction from the ground, etc. (It may be noted that the wasting of the natural resources themselves by removal of the basic materials is known as *depletion*). The production unit method of depreciation ensures a rational and uniform charge of depreciation over the work done by the asset. When an asset is idle and produces nothing, no depreciation is charged. On the other hand, if production is increased by working beyond normal hours or by an increase in the productivity of the assets, the amount of depreciation charged also increases. The main disadvantage of the method is that a separate record of output of each of the assets is required to be maintained. The method suffers from the further limitation that it cannot be applied when the various outputs from an asset are not identical or uniform, or cannot be measured in terms of a homogeneous unit.

(ii) *Production hour Method.* This method also does not take the time factor into account. A fixed rate of depreciation per hour of production is calculated by dividing the value of the asset less its salvage value into the estimated number of hours for which the asset is likely to run during its life time. With the figures assumed in the previous examples and an estimated number of hours (t) of 19,500 for the entire life of the asset :

$$\text{Rate of depreciation per hour} = \frac{V-s}{t} = \frac{\text{Rs. } 20,000 - \text{Rs. } 500}{19,500} = \text{Rs. } 1.00$$

The production hour method has the additional advantage that it can also be used in cases where the production of an asset is not in identical or uniform physical units.

C. Method based on both usage and time factors

Joint rate Method. In this method, the depreciation is a composite amount consisting of two elements—one for the passage of time and the other for the usage of the asset. The proportion of each of the two elements is estimated and calculated separately, in accordance with the methods discussed above. The two parts when combined together, constitute the amount of depreciation chargeable. Assuming that out of the total cost of Rs. 20,000 of an asset (life = 15 years and residual value = Rs. 500), Rs. 15,000 is depreciated on time basis and the rest (Rs. 5,000) on usage basis, and that the total hours worked by the asset during the accounting period (i.e. the year) are 1,000 out of a total of estimated 19,500 hours for the whole life of the asset, the depreciation, under this method, will be worked out as follows :-

Annual depreciation on time basis (straight line method)

$$= \frac{\text{Rs. } 15,000 - \text{Rs. } 500}{15} = \text{Rs. } 966.67$$

Annual depreciation on usage basis (production hour method)

$$= \frac{\text{Rs. } 5,000 \times 1,000}{19,500} = \text{Rs. } 256.41$$

Total depreciation = Rs. 256.41 + Rs. 966.67 = Rs. 1,223.08 per year

The joint rate method involves considerable clerical work but is suitable where an asset works intermittently, and there are periods of idleness followed by periods of normal and sometimes, overtime work. The element of depreciation on time basis is a fixed element and that on the usage basis is a variable element, thus making the composite rate a semi-variable factor.

D. Method based on maintenance factor

Repair provision method. This method provides for periodic charges to costs of the aggregate of depreciation and maintenance costs, each of the periodic charge being a constant proportion of the aggregate of the cost of the asset depreciated and the anticipated maintenance cost during its life. The special feature of the method is that maintenance cost is spread uniformly over the life of the asset, thus avoiding peaks and depressions of maintenance costs from one period to another. The assessed maintenance cost is added to the original cost of the asset and the rate of depreciation is worked out under any of the methods discussed earlier. The actual expenditure incurred on maintenance is not charged to costs but is charged against the amounts provided by the depreciation charges. Assuming the previous figures and an assessed maintenance cost (m) of Rs. 12,500 for the life period of the asset, the depreciation will be calculated as under :

$$\begin{aligned} \text{Rate of depreciation} &= \frac{V - s + m}{n \times V} \times 100 \\ \text{(Straight line method)} &= \frac{\text{Rs. } 20,000 - \text{Rs. } 500 + \text{Rs. } 12,500}{15 \times \text{Rs. } 20,000} \times 100 \\ &= 10.67\% \text{ per annum} \end{aligned}$$

A serious limitation of this method is the uncertainty involved in assessing the maintenance cost of the asset over its life for a number of years.

E. Methods which take into account the revenue earning factor of the assets

(i) *Annuity method.* The annuity method is based on the assumption that the capital sunk in the purchase of the asset would have earned interest if otherwise invested. The depreciation charge per period calculated under this method is a constant proportion of the aggregate of the cost of the asset depreciated and interest at a given rate, per period, on the written down value of the asset at the beginning of each period. Assuming the previous data and an interest rate (r) of 5% per annum :

$$\text{Annual depreciation} = \frac{V \cdot r}{1 - \frac{1}{(1+r)^n}} = \frac{\text{Rs. } 20,000 \times 0.05}{1 - \frac{1}{(1.05)^{15}}} = \text{Rs. } 1,926.85$$

The amount of depreciation is heavy in this method and is intended to cover the cost of opportunity lost by not investing the capital elsewhere. This is suitable for depreciating leasehold buildings where no subsequent additions are made to the asset and the residual value is nil.

(ii) *Sinking Fund method (also known as Redemption or Amortisation method).* In this method, the depreciation is an amount which, aggregated with compound interest on it over the life of the asset, equals the cost of the asset. Simultaneously

with each periodic charge for depreciation, an investment of the same amount is made in fixed interest securities which would accumulate at compound interest to provide, at the end of the life of the asset, a sum equal to its cost. The method is also used for amortising, i.e. for recovering the capital value paid for leasehold in the accounts over a fixed period.

Depreciation under this method is calculated as shown below .

$$\text{Depreciation per year} = \frac{Vr}{(1+r)^n - 1} = \frac{\text{Rs } 20,000 \times 0.05}{(1+0.05)^{15} - 1} = \text{Rs } 926.85$$

It will be seen that the amount of depreciation is lower than in the annuity method and the total amount of depreciation (Rs. 926.85 × 15 = Rs. 13,902.75) is less than the cost of the asset. The basic purpose of this method is to provide ready liquid funds at the time of replacement. It may not, however, be always possible to make such investment if the money is required to be diverted for a urgent and more useful purpose.

(iii) *Endowment policy method.* The method is similar to the sinking fund method. An insurance policy is taken out for the amount required for replacement of the asset at the end of its life. The amount of depreciation that is charged to cost is equivalent to the premium payable on the endowment policy. The amount of premium is determined by insurance companies and no formula for the same has been shown here

F. Revaluation method. The method involves periodical valuation of an asset and is suitable for such assets as loose tools, patents, livestock, plants in a contract work, expensive tools which have been capitalised, and plants and equipments specially procured for a project. This method is also suitable where the asset is used intermittently and where it is necessary to correctly determine the charge for the services of the asset and its residual value after each spell of use. The amount of depreciation charged is equivalent to the difference between the values assigned to the asset at the beginning and the end of the period

Depreciation rates. Calculation of depreciation according to the methods described above may be made individually for each asset or for groups of assets, or for all the assets combined together. Depreciation is, sometimes, charged at an accelerated rate. Depending upon these requirements, the following types of depreciation rates may be employed :—

(a) *Single rate :* A single rate of depreciation is calculated by reference to the estimated life of a single asset. The rate is applicable where costly assets, small in number, produce only a specific type of product or render a specific service. With a large number of plants and machines, the method becomes cumbersome and expensive. When several machines are utilized for producing the same product, individual rates are applied for each machine and the total charge to the product is the aggregate of the depreciation charges of the individual machines. This procedure is also adopted when the total depreciation of all the machines in a department or cost centre is required to be charged to the departmental overheads. The disadvantage of the single rate is that the calculations required to be made increase with the number of the assets.

(b) *Composite rate* : The rate is calculated by dividing the aggregate of the individual depreciation charges (in whatever manner calculated) of all the assets concerned, in any one period, by the aggregate of the cost of the assets.

$$\text{Composite rate} = \frac{\text{Aggregate of depreciation charges for all assets}}{\text{Total cost of assets}}$$

The rate is applicable when several assets having different lives are utilized for the production of one type of product. This is particularly useful in case of processes or departments where all the plants and machinery are applied for work of a uniform type. The distinction between single and composite rates of depreciation is illustrated in the table given below :

Machin	Cost of machine (Rs.)	Estimated life (years)	Residual value (Rs.)	Annual depreciation calculated on straight line basis (Rs.)	Single rate %	Composite rate %
1	14,500	14	500	1,000	6.9	
2	21,000	10	1,000	2,000	9.5	
3	50,000	12	2,000	4,000	8.0	
4	25,500	12	1,500	2,000	7.8	
5	43,000	10	3,000	4,000	9.3	
	1,54,000		8,000	13,000		8.4*
	(* $\frac{\text{Rs. } 13,000 \times 100}{\text{Rs. } 1,54,000}$ 8.4%)					

Where the various machines are employed on different types of work, the application of a composite rate will not be rational as this will result in disproportionate charge of depreciation to the products, i.e. overcharge in some cases and undercharge in others.

(c) *Accelerated rate* : This rate consists of a normal depreciation rate augmented to provide additional depreciation sustained by the asset depreciated. Except in the case of methods which take the usage factor into account, the usual rate of depreciation is adequate only for normal usage of the asset. For abnormally increased usage, the rate should be revised and accelerated to cater for increased usage as otherwise, costs are understated. For example, if an asset works in double or triple shifts instead of the normal one shift, the rate of depreciation may be doubled or trebled, as necessary. If an asset works only for a part of the second or third shift, the rate of depreciation may be adjusted proportionately. For income tax purposes, however, additional depreciation to the extent of 50% of the normal depreciation is charged for double shift working and for three shift working, the additional depreciation charged is 100% of the normal.

(d) *Retarded rate* : This rate consists of a usual depreciation rate reduced to cater for less depreciation due to reduced usage of the asset depreciated. This is based on the same principles as the accelerated rate ; an appropriate reduction is made in the rate for the decreased usage or idleness of the asset. Some concerns, for example, calculate depreciation for idle machines at two-thirds the normal rate.

Methods that take into account the acceleration and retardation of depreciation are based on the activity factor. This is illustrated below (assuming that the production unit or production hour method is adopted) :

	Activity factor :
Normal depreciation - Rs. 2,000	Month A : $\frac{1,500}{1,000} = 150\%$
Budgeted production : 1,000 units per month	Month B : $\frac{750}{1,000} = 75\%$
Actual production :	Depreciation charged
Month A : 1,500 units (above normal)	Month A : 150% of Rs. 2,000
Month B : 750 units (below normal)	= Rs. 3,000 (accelerated)
	Month B : 75% of Rs. 2,000
	= Rs. 1,500 (retarded)

Depreciation of life expired assets. Sometimes it so happens that an asset, say, a machine is capable of rendering effective service even after the expiry of its normal life when its entire cost has been recovered and the asset stands in the records at nil or scrap value. Such a situation may arise due to one or more of the following causes :

- (i) Overcharging of depreciation due to adoption of a higher rate.
- (ii) Incorrect assessment of the working life of the asset.
- (iii) Efficient maintenance leading to prolongation of the life of the asset.
- (iv) Continued use of the asset due to difficulties in its replacement.

As the machine is still in use and will be rendering service in production, depreciation should continue to be charged in the costs of the products which utilize its services. Unless depreciation is charged, the cost of products manufactured by the time expired machine will be understated and will not, therefore, be comparable with the costs of the earlier periods.

Assessment of the second working life of the asset should be based upon technical considerations. The machine should be revalued and the new value credited to the Profit and Loss Account and debited to the Assets Account. If the newly assigned value is large, the alternative method is to credit a capital reserve account. If the life of the machine is assessed at more than one year and if it is not considered reasonable to credit the enhancement of value to the profit of one year only, the amount of new depreciation charged each year and not the entire assessed value is credited to the Profit and Loss Account of the year by debiting current costs. A suitable rate of depreciation should be worked out and charged every year in the usual manner. The additional depreciation so charged creates an additional fund that would meet the increased cost of replacement of the asset, if such a necessity arises in future. In the cost ledger accounting system, the amount is credited to the Costing Profit and Loss Account.

Depreciation on replacement value of assets. Depreciation may be charged on the original cost of acquisition or on its replacement cost, i.e. on the amount that would have to be paid on the date of replacement of the asset. Fixed assets have a relatively longer life so that when after the expiry of the serviceable life of an

asset, its replacement is being considered, it is seen that cost of the new purchase is different—usually high—due to change in the price level during all these years of the asset's life. When depreciation is calculated on the basis of replacement value, the amount charged will ordinarily be high so that the funds created out of the depreciation would be sufficient to meet the increased requirement for plant replacement. Obviously, the replacement cost method is not applied in periods of deflation when prices are falling.

The arguments put forth in favour of replacement value method are summarised below :

- (a) It ensures that sufficient funds are available for replacement, particularly when prices have in the meantime gone up due to general inflation, or if costlier machines incorporating the technological advancements made since the last purchase, are required in replacement.
- (b) Depreciation is charged at a higher rate in production costs and it represents the real monetary value of the service rendered by the assets, the cost of which is rising.
(The following points in favour of the replacement value method actually state the *limitations* and *disadvantages* of the original cost method)
- (c) Real profits are not revealed under the original cost method since depreciation is always undercharged.
- (d) Original cost method inflates the profit or shows profit where there is actually a loss.
- (e) Under the original cost method, there may be the tendency to fritter away higher profits by paying higher rates of dividend. This acts against the interest of preference shareholders. Higher profits would also make the company liable to pay higher profits bonus.
- (f) Cost price of assets is only of historical interest and is not related to current market conditions.

The arguments against the replacement value method are as follows :—

- (a) Depreciation should be based only on historical costs as reflected in the accounts.
- (b) Additional depreciation should be appropriated from profits and should not be a charge against production costs. Replacements need not necessarily be met from depreciation only.
- (c) Difficulty in correctly determining the replacement value makes the method arbitrary and unrealistic ; cost is vitiated by the inclusion of fictitious figures.
- (d) Technological improvements over time result in change in design, performance, speed, capacity, etc. of an asset so that the question of replacement on a like-to-like basis would perhaps never arise and the asset obtained in replacement may be entirely different from the one which is being replaced.

- (e) Value of work-in-progress and finished goods, cost of production, and cost of sales are inflated and do not reveal the real position.
- (f) The method has the effect of lowering profits that may adversely affect the shareholders who do not get the appropriate dividends but are, at the same time, confronted with the lowering of the value of the shares they hold.
- (g) Depreciation charged at an enhanced rate under the replacement value method is not acceptable by the income tax authorities.

During periods of rising price levels, as is the condition today, fixed asset replacement presents a problem because the sinking fund created for the purpose, from out of the depreciation charged on the original cost basis, is not sufficient and working capital is gradually depleted. Three methods are available for meeting the situation :

(i) The costs of the fixed assets are written up to conform to the replacement value and depreciation is charged on the basis of the latter.

The method has the following *advantages* :-

- (a) With increasing price level, the real value of the amount of depreciation charged to costs decreases. Charging depreciation at an increased rate accounts for this erosion in the value and makes a fair charge to cost of production for the services of the assets utilized.
- (b) Cost of sales and inventory of work-in-progress and finished goods are shown in real terms in so far as depreciation is concerned. As there is no undercharging of depreciation, profits are realistically stated.

(ii) Depreciation may be calculated on the historical costs, i.e. on the original costs but additional funds may be set apart from out of profits. Thus a special reserve is created to meet the additional cost of replacement.

(iii) A fixed asset may be worked for a period longer than its original expected life. A larger fund is thus accumulated to meet the additional cost of replacement. This method is, however, not very practical because extending the life of an asset is not always within the control of the management and sometimes due to obsolescence or other causes, an asset may have to be discarded long before the expiry of its life.

Drawing Office and Design Cost. All expenses connected with Design and Drawing offices may be merged into a separate service cost centre and apportioned to the producing cost centres on the basis of the number of drawings made, chargeable man-hours or any other technical estimation according to the services rendered by the centre. Small expenditure requiring no detailed analysis may be treated as administration overhead. Drawings to be enclosed with sales tenders may be treated as selling overhead. Drawings and designs prepared for specific one off production may be treated as direct expenses.

Erection and Dismantling of Plant and Machinery. When machinery is erected and installed, the normal routine is that the entire expenditure is capitalised

along with the cost of machinery and thus absorbed through depreciation. But sometimes it may be necessary to dismantle the existing installation and re-erect the plant at a different location, or simply change the layout. The expenditure involved in such cases may be charged to overhead. A situation may arise when an asset is to be prematurely dismantled before the expiry of its normal life in order to make room for a new asset procured in replacement. This may be due to the fact that the existing asset might be inadequate to meet current requirements or it might have become obsolete, superfluous, or redundant in the present circumstances. The balance value of the asset, i.e. the original cost less depreciation charged that far, is a loss which being an abnormal loss is not charged to cost of production. The loss may be charged off to the Profit and Loss and Account entirely in the year in which it occurs or it may be spread over a number of years that may extend up to the balance life of the asset. The amount to be charged off is reduced by the sale value, if any, which the disposal of the asset fetches.

In certain cases when the life of an asset is completed, there still remains a residual value. This value and the sale value of scrap are treated as overhead in the same way as depreciation, in the final year of the asset's life.

Fines Realised from Workers. Fines recovered from workers cannot be taken as receipts or income. In accordance with the Payment of Wages Act, fines are credited to a separate Fine Fund to be utilized for welfare purposes. The credit as well as expenditure from the fund are excluded from cost accounts.

Fire Prevention Cost. All large undertakings usually have a special fire-fighting department which is equipped with fire-fighting implements and materials and trained staff. All expenses in connection with fire-fighting are allocated to this department which is treated as a service cost centre. The cost of the centre is ultimately apportioned to the producing and other service cost centres on some technical estimation based on the fire risks, value of material handled or value, area, or cubic capacity of buildings. If a particular department or process involves greater fire risks, the apportionment may be suitably weighted.

Small or medium sized factories may not always be able to afford a full-fledged fire fighting department. In big cities where fire-fighting services can be easily obtained almost immediately on call, even big factories need not maintain fire-fighting departments of their own. In such cases, a few essential fire-fighting and fire preventive implements are maintained for use in case of emergency, the total expenditure on which may not be large enough to merit a detailed analysis. All such expenditure may be booked against a standing order number and included in maintenance costs.

Fringe Benefits to Employees. Besides wages and salaries and dearness allowance, supplementary labour costs are incurred by the management to cover a variety of benefits called fringe benefits, which the industrial workers usually enjoy. Fringe benefits are payments not related to the direct efforts of the employee, e.g.,

(i) Holiday pay

- (ii) Leave Pay
- (iii) Sick pay (including maternity, accidents, etc.)
- (iv) Employers' contribution to provident fund, retiring gratuity, and pension schemes
- (v) State insurance and medical benefits
- (vi) Bonus and allowances like attendance bonus, shift allowance, hardship allowance, etc.
- (vii) Canteen benefits.

These expenses cannot be allocated to cost units direct but may be allocated to the particular departments or cost centres in which the workers are employed. The cost of fringe benefits are, therefore, treated as items of departmental overhead and booked to standing order numbers allotted for each type of such expenditure. In several cases, the expenditure is not incurred uniformly in each accounting period. For example, the payment on account of holiday pay is not uniform because the number of holidays is not the same in each accounting period. In order to obviate uneven charge to costs, benefits for the whole year are anticipated and proportionately charged in each period.

As regards retiring and pension schemes, a reserve is usually created in the accounts to meet future payments, the amount of provision made being treated as overhead. Even if no such provision is made, a suitable amount per worker may be computed and charged to overhead as superannuation costs. The idea underlying this procedure is that the amount though payable at a future date should be recovered uniformly from current production costs. Costs of pensions and other superannuation costs may be allocated direct to cost centre ; if not, apportionment may be made on the basis of the number of employees or total wages paid. Alternatively, (i) the wage rate of each worker of a cost centre may for the purpose of allocation be inflated to cover an estimated cost of pension, or (ii) a separate overhead rate on direct wages may be worked out for each cost centre and charged to the cost of production. In both the cases, the difference between the amount charged and the actual payment during a period may be included in the overhead for the next period for the purpose of calculating overhead rate. The difference remaining at the end of the year may, however, be charged to the Costing Profit and Loss Account.

Inspection Costs. The main function of an Inspection Department in a manufacturing organisation is to ensure control on the quality of output by revealing sub-standard and defective work, and pin-pointing the causes leading to them. The inspection department may be responsible for the inspection of incoming raw materials and supplies, finished processes, products, parts and components, and work-in-progress at various stages of completion. The last named type of inspection which is known as 'stage inspection' detects defects at earlier stages of manufacture and is, therefore, sometimes essential for keeping down the cost of defective work in costly items of manufacture.

Inspection Department is taken as a separate service cost centre where all expenses compiled under different standing orders for each type of inspection

are allocated direct and the proportionate share of other service centres are added. The total cost of the Inspection Department is then apportioned to the producing cost centres according to the service rendered to each. The time spent by the inspection staff in each cost centre is an appropriate base for this purpose. When inspection staff is directly employed in the shops, inspection costs may be allocated directly to such shops. Inspection costs relating to raw materials and supplies are usually merged with materials handling or storage expenses. Similarly, cost of inspection of finished products is allocated to warehouse stock handling expenses and charged to distribution costs. Inspection personnel are often required to test articles produced under a research scheme. The cost of such inspection forms a part of research cost. Expenditure on inspection relating to purchase of fixed assets should be capitalised.

Insurance. The insurance premium paid by a concern may cover various kinds of insurances. Insurance of plant and machinery, buildings, and equipments usually covers risks of general loss and fire. The amount of premium which is based on the value insured is allocated to particular departments or cost centres as items of overhead costs. Premiums for insurance of warehouse stock are charged to distribution overhead ; those for raw material stock to manufacturing overhead, and the payments for insurance against loss of ~~stock~~ burglary etc. are treated as administration overhead.

The cost of insurance for plant and machinery, vehicles, and buildings, if not directly allocated, is apportioned on the basis of number, value, or area or cubic capacity. Accident insurance may be apportioned on the basis of total wages in each cost centre with suitable weightage for those centres which are more prone to accidents.

Insurance charges paid at the time of purchase are charged direct to the cost of the material or asset purchased.

Lighting, Heating, Air-conditioning, Ventilation etc. Expenses. Depending upon the extent of the services utilised by the main functional organisations of the undertaking, the expenses on lighting, heating, and air-conditioning are allocated or apportioned to the manufacturing, administration, selling and distribution overhead. If the services rendered to the cost centres are metered or can otherwise be measured, the expenses are allocated to the centres. If this is not possible, apportionment is made according to number of electric points, wattage, floor area, cubic capacity, etc.

Maintenance and Repairs costs. Maintenance and repairs constitute an essential requirement of a manufacturing concern and have assumed added importance due to the use of costly and complex plants, machinery, and equipments in the modern industry. The purpose of repairs and maintenance is firstly, to keep the equipments in perfect condition so as to reduce likely wastage or loss due to their deterioration, and secondly, to reduce interruptions in production due to breakdown so as to ensure optimum utilisation of the equipments. Depending upon the size and the specific requirements of a concern, there may be more than one maintenance department in a factory that may be responsible for

maintenance and repairs of plant, machinery and machine tools, buildings and works, and electric, heating, refrigeration, water, gas, and power installations.

The functions of maintenance department may be divided into two parts, viz. (i) *Preventive maintenance* and (ii) *Corrective maintenance*. Preventive maintenance includes a planned periodical check up and inspection of the equipments and provisions of repair and maintenance services for their continued efficiency even while the assets are in service. Preventive maintenance is thus, more or less, a routine affair involving a continuous process carried out according to schedule ; it anticipates breakdowns and takes timely measures to forestall them. The need for corrective maintenance, on the other hand, arises on special occasions when due to sudden breakdowns and stoppage of work, emergency repairs are required.

The expenses on repairs and maintenance are treated as items of overhead costs and each type of such expenditure is booked to a separate standing order number against each department or cost centre. Each maintenance department constitutes a service cost centre. For an effective control, repairs and maintenance work should be authorised on *Service Orders* in the same way as jobs are authorised on production orders, separate service orders being issued for each type of repair and maintenance work. This would be appropriately suited in the case of special or breakdown maintenance. Each service order is costed and departmentalised for absorption in the overhead of the respective departments. Alternatively, an omnibus service order may be issued to cover maintenance in each department or cost centre.

As maintenance expenses themselves constitute overhead costs, no portion of service and administration overheads are normally added to service order costs. However, in order to have an effective control, it is advisable to charge the service orders with full costs, i.e. labour, material, and proportionate share of service overhead. This would enable comparison of maintenance costs against predetermined budgets. Each service order thus 'stands by itself', and it is possible to install a system of responsibility accounting, whereby each departmental foreman is made responsible for the maintenance costs pertaining to his department. Maintenance services are meant primarily for utilization in producing centres and the production shop executive places requisitions for the maintenance services in his shop. The maintenance staff having to work mostly in the production shops, the maintenance foreman or engineer can have only a remote control over the day-to-day work of such staff. The responsibility for controlling the maintenance expenditure in a shop, therefore, lies with the shop executive who is furnished with information regarding the total maintenance cost incurred in a period in his shop, under different standing order numbers.

Usually, periodical preventive maintenance is carried out during periods when production is lean or slack as it is not possible to shut down plants for repairs and maintenance during peak periods. Special or emergency maintenance may, however, be carried out at any time of the year. It will thus be seen that the incidence of maintenance expenditure is not only not uniform in all the months of the year but it has no direct relationship with the volume of production. Maintenance expenditure if charged to cost of production in the month it is incurred, would result in wide monthly variations of costs. This can be avoided by averaging

out the expenditure and charging only the proportionate amount to each month's cost of production. A Repairs and Maintenance Reserve Account is opened and a fixed amount is provided as reserve in the accounts every year. Actual amounts, as and when incurred, are set off against the reserve. Expenditure on major overhauls and heavy repairs and replacements is usually large and the entire benefits of such expenditure may not be achieved in one financial year. The expenditure should not, therefore, be fully charged to the current revenue but treated as deferred maintenance costs and recovered in the production costs of subsequent periods. Alternatively, it may be included in the depreciation rate. When the maintenance and repairs have the effect of improving the existing assets so as to increase their productive or earning capacity, the cost is treated as capital expenditure.

It is sometimes necessary to have duplicate standby plants for use in case of breakdown or repairs. As such plants depreciate on time basis even though not in use, estimated amounts should be suitably provided while compiling machine hour rates of the existing usable plants.

Control of maintenance cost through budgets and standards has been discussed in Chapter 11.

Material Handling Expenses. Material handling expenses should be distinguished from storage or store-keeping expenses though in many concerns the two are combined for the purpose of accounting. Materials handling expenses comprise the expenses for handling raw materials and supplies, work-in-progress, finished stock, and other materials. Materials handling also include weighment of materials at various points before and/or after carriage to respective destinations and comprises such expenses as wages of weighmen, depreciation of weighing machines, etc. In its broader sense, materials handling also refers to the materials movement, i.e. internal transport of materials within the factory. (Also see Page 236.)

Materials handling expenses may be apportioned on the basis of value, weight, or volume of materials or number of materials requisitions handled. These may also be allocated to the cost of materials consumed on the basis of a percentage rate.

Materials Re-conditioning (during Storage) Expenses. At times it becomes necessary to recondition materials in storage by means of minor operations like de-rusting, re-painting, and polishing in order to restore them to proper usable conditions. Normal re-conditioning expenses may be charged to the cost of the material. If the amount of expenditure is high or is incurred as a result of careless storage, addition to material cost may not be desirable and hence, the expenses may be booked to the relevant standing order number as overhead cost.

Material Storage (Store-keeping) Expenses. Storage expenses include salaries and wages of storekeeping staff, depreciation of storage equipments, and losses of stores during storage such as due to evaporation, deterioration, and break up of bulk material. The amount of the expenses is worked into a rate or percentage of

total material consumed and charged to costs as an addition to the cost of material. Alternatively, the expenses may be treated as overhead costs and apportioned on the basis of value of materials stored or the number of materials requisitions handled.

Materials Waste and Losses. Waste or loss of materials may arise during storage, in transit, or during the process of manufacture.

- (a) *During storage:* Some materials suffer inherent shrinkage or evaporation during storage. Some waste is also inevitable in the process of cutting up and weighing of materials, or due to some unusable residues. Such wastes and losses are adjusted at frequent intervals or at the time of physical stock-taking. The amount of difference is charged as overhead cost to the relevant standing order number for store adjustment. Alternatively, the purchase price of materials may be inflated to cover such possible losses.

Losses such as breakages, pilferage, abnormal evaporation or shrinkage, and deterioration of quality caused due to wrong handling or storage are adjusted and charged to overhead. Different standing order numbers are allotted for each type of loss.

Abnormal losses like those caused due to fire, flood, storm, etc. beyond the control of the management are also booked to relevant standing order numbers. If the amounts are heavy and not recoverable from the insurance companies, it is preferable not to load the cost of production and hence, abnormal losses are charged to Profit and Loss Account or Costing Profit and Loss Account.

- (b) *In transit :* If free replacements are made by the suppliers, the carriers, or insurance companies, no cost accounting problems arise but if losses are borne by the concern, adjustments are made by charging to the relevant standing order numbers. The question whether the expenditure will be included in the costs as overhead or excluded from costs, depends upon the amount ; while small amounts may be charged to overhead, heavy expenditure, to the extent not covered by insurance, should be treated as abnormal and charged to Profit and Loss Account or Costing Profit and Loss Account.
- (c) *During production :* The cost of normal waste etc. in respect of materials of a general nature which have the inherent characteristics of evaporation or shrinkage during processing remains charged to the job or process and no additional accounting adjustments are needed once such materials are issued to jobs. Waste materials and scrap arising during processing are normally returned to Stores on materials return notes. The return is priced at a suitably reduced rate—usually at the sale price of the waste or scrap less selling and distribution costs, if any—and the original job or production order for which the material was initially drawn is credited with the value of the waste or scrap.

When scrap cannot be identified with a job, no credit for it is taken in the costs of jobs ; the sale value realised is credited to overhead or alternatively, to the Profit and Loss Account, as miscellaneous receipt. Costly scrap is, however, credited to the job or product cost on the basis of the percentage of anticipated scrap provided in the estimates for each type of output. When the waste arising out of a process is transferred to another process, suitable credit is given to the former and debit to the latter.

Power Costs. Power costs include the expenses on electricity, gas, steam, compressed air, and such other motive power. Power may either be purchased or generated in the factory or it may be purchased as well as generated. The cost of power purchased is allocated to the cost centres on the basis of meter readings. If no meters are provided, the cost is apportioned on the basis of rated capacity, wattage, horse power of machines, horse power multiplied by machine hours, or such other technical assessment.

The payment made for power purchased comprises, besides the cost of units purchased, several types of other charges some of which are :

- (i) Minimum charge irrespective of the quantity of power consumed.
- (ii) Demand charge or peak charge for the maximum quantity used at any period of time.
- (iii) Low power factor penalty.

Each of these charges should be apportioned to the various plants and machines depending upon the factors which cause the incidence of such charges. For example, the minimum charge may be apportioned in the following manner :—

	Total	Plant A	Plant B	Plant C
Maximum capacity to use electric power in period (units)	10,000	2,000	3,000	5,000
Actual consumption	7,600	600	2,500	4,500

If the minimum charge be for 8,000 units, the proportion to the three plants will be :

$$\text{Plant A} = \frac{8,000}{10,000} \times 2,000 = 1,600 \text{ units}$$

$$\text{Plant B} = \frac{8,000}{10,000} \times 3,000 = 2,400 \text{ units}$$

$$\text{Plant C} = \frac{8,000}{10,000} \times 5,000 = 4,000 \text{ units}$$

As the consumption of Plant A fell below the minimum, the entire extra cost should be borne by that plant. Assuming the rate per unit to be Re. 0.10, the extra cost is.

Minimum charge	8,000 units \times Re. 0.10 = Rs. 800
Actual consumption	7,600 units \times Re. 0.10 = Rs. 760
	<hr/>
Excess charge	= Rs. 40

The apportionment of power cost to the three departments will be :

	Total	Plant A	Plant B	Plant C
	Rs.	Rs.	Rs.	Rs.
Actual consumption (units consumed \times Re. 0.10)	760	60	250	450
Difference between minimum charge and actual consumption.	40	40	—	—
	Rs. 800	Rs. 100	Rs. 250	Rs. 450

When power is not purchased but generated internally, the cost of power generation and distribution is booked to a standing order number. Usually there is a separate department, e.g. Power House which constitutes a cost centre to which all power expenses are allocated. The expenses of the power house are further allocated and apportioned to the other cost centres. The method usually adopted is to prepare a separate operating cost statement showing the cost of generation of electricity, steam, etc.

Another method of apportionment of the cost of power generated is on what is known as the **two basis**. The power cost is segregated into two elements, viz. (i) fixed or standby cost, the incidence of which does not depend upon the units generated, and (ii) the variable cost which is related to the quantity of power generated. The fixed cost is apportioned on the basis of the maximum power consuming capacity of a department and the variable cost is apportioned (allocated, if metered) on the basis of actual consumption.

A specimen form for power cost statement suitable for thermal power plant is given in Fig. 4.8.

Profit Bonus. Normally, this is not taken as an item of cost because such bonus can only be paid out of profits. However, under the provisions of Payment of Bonus Act, a minimum bonus is payable by the employers. As this payment is obligatory, it should be charged against cost of production but any excess over the minimum paid out of the available surplus is an appropriation of profit and should not, therefore, be treated as an item of cost. Another school of opinion is to charge the entire payment to cost treating it as a charge to profit and not as an appropriation of profit, particularly when bonus is recognised in income tax laws as charge against profits. As payment is made only after the closing of the accounting year (within eight months from the date of closing as per the Act), provision for payments is made in the accounts on an estimated basis and the amount included in overhead. Apportionment is made on the basis of amount of wages or the number of employees in case it cannot be allocated to the cost centres.

Safety Costs. The Factories Act stipulates measures to be taken in regard to health and safety of workers. In addition to these measures, many concerns take particular care to ensure safety so that industrial accidents and the resultant loss of production are brought down to the minimum. Safety cost is treated as an

Units sent out.....KWH	Month.....	ANALYSIS OF ELECTRICITY											
Load factor.....%		Ratio of fixed cost based on load factor		Amount		Cost per KWH sent out		Running		Total		Cost per KWH previous year	
				Fixed	Running	Fixed	Running	Fixed	Running	Fixed	Running	Fixed	Running
				Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
										</			

Fig. 4.8. Power Cost Statement

item of overhead and it would generally include salaries and wages of safety personnel, protective clothing, machine guards, medical and first aid supplies, safety committee costs, cost of training for safety, depreciation of safety equipments etc. For the purpose of control, safety costs may be measured as cost per employee or cost per accident.

Set-up Cost. After completion of a particular batch or quantity of production of a specific operation, a machine requires setting up with a different set of tools, jigs, fixtures, etc. for taking up the next batch of production. This is essential for preparation of the subsequent run of production. Set-up cost is, therefore, normally charged to the particular job order or production order for which the preparation has been made.

But when setting is frequent and the costs abnormally high as compared to the operation cost, the situation demands proper measurement and control of set-up costs and it may be preferable to treat the cost as overhead for booking against all orders equitably.

Incidentally, set-up cost decides the optimum lot size of production. If the cost is high, larger batches of production will be economic, but this has to be weighed against high cost of storage and interest due to increased inventory. This is discussed further in Chapter 7.

Training Cost Most manufacturing organisations have a scheme for training of workers, apprentices, and staff. The cost of such training would generally comprise wages and salaries of the trainees or learners, pay and allowances of the training and teaching staff, payment of fees etc. for training or for attending courses of studies sponsored by outside organisations, and cost of materials, tools, and equipments used in training work. All these costs are booked under separate standing order numbers for the various functions, viz. manufacturing, selling and distribution, and administration. Usually there is a service cost centre, known as the Training Section, to which all the training costs including the share of overhead from other service cost centres are allocated and/or suitably apportioned. The total cost of the training section is thereafter apportioned to the producing cost centres under the usual procedure, adopting a suitable base for the purpose. The base commonly adopted is the number of trainees in each cost centre.

In course of training, the trainees may do some useful productive work. The training section is credited with the estimated cost of the product manufactured, corresponding debit being made to the production order concerned.

Transport Cost. Transport costs may be classified under three broad heads as follows :—

- (i) 'Carriage in' on materials coming inside the factory.
- (ii) Internal movement of materials in the factory.
- (iii) 'Carriage out' for stores sent outside.

Movements of materials inside the factory are usually referred to as *materials movement* (or *handling*) problems. The movement of finished stocks outside, say to warehouses, is a problem of *physical distribution*. The two types of movements together constitute, what is known as *materials logistics*.

The cost of 'carriage in' for the transportation of raw materials is allocated direct and forms part of the cost of such materials. When this is not practicable and allocation to specific items of materials is difficult, the expense is treated as manufacturing overhead and booked to a standing order number. The procedure adopted in some undertakings is to charge transport cost as a percentage of cost, weight, or some other physical unit of material. Transport cost on capital assets or materials directly utilised against capital work orders should be charged to the asset concerned.

Cost of transport of materials returned to the suppliers is also a charge to manufacturing overhead, if the expenditure is not borne by the supplier. In a non-manufacturing concern where goods are purchased for re-sale, transport expenses are either added to the cost of the goods purchased or charged to selling and distribution overhead. When goods are delivered free at customers' premises, the cost of transport is charged to distribution overhead.

Internal transport for the movement of materials between departments inside a factory is usually under the control of an internal transport department which, for the purpose of accounting, is treated as a service cost centre. The cost of such internal transport is treated as an item of stores handling charges and apportioned to cost units on a suitable basis. The bases for this purpose are tonne-kilometre, kilometre, and volume, weight, or value of materials transported.

In some concerns, the internal transport cost is further subdivided into different cost centres according to, (a) the services rendered to the departments, (b) nature of the movement, and (c) nature of equipment such as conveyors, cranes, elevators and hoists, trailers, motor vehicles, and locomotives. Costs of cranes, elevators, and hoists may, for example, be first booked to say, a crane cost centre or department and subsequently apportioned on suitable basis (say crane hours) to the various cost centres or cost units according to the service utilized by each cost centre or cost unit.

'Carriage out' is incurred for the transport of finished products and the cost is chargeable to distribution expenses. If the same transport equipment is utilized for both inward and outward movements, i.e. for transporting raw materials inside the factory as well as for carrying finished goods outside, the total expenses are apportioned and recovered on a suitable basis according to some physical measure of the load carried or on the basis of service rendered, such as truck hours or truck kilometres.

Basis of Apportionment of Specific Items of Overhead. The bases for allocation and apportionment of some items of overhead costs to cost centres (primary distribution) and of the apportionment of the costs of certain service cost centres to producing cost centres (secondary distribution), which have not been previously discussed, are briefly summarised below.

<i>Items of cost</i>	<i>Basis of apportionment</i>	<i>Remarks</i>
Accounts office	Number of employees Number of time tickets handled Analysis of time spent for each department	

<i>Items of cost</i>	<i>Basis of apportionment</i>	<i>Remarks</i>
Crane service	Crane hours Weight of material handled Combination of weight and hours (Kilogram-hours or Tonne-hours)	Crane cost divided by crane hours or by the weight of materials gives a rate for apportionment.
Fuel	Direct allocation by weight or meter readings Estimates of issues	The purchase vouchers indicate the department to which chargeable.
Indirect labour	Direct allocation to cost centres	The allocation is done through wages analysis sheets or payrolls.
Indirect material	Direct allocation to cost centres	Materials requisitions or materials issue analysis sheets provide data for allocation.
Jigs, Tools, and Fixtures	Machine hours Man hours	Special jigs, tools, and fixtures are chargeable direct to jobs or products. Costly items are capitalized.
Laboratory	Laboratory hours Units of productive output	A rate is obtained by dividing the laboratory cost by the number of hours or units of production.
Machine Accounting	Number of cards punched Man hours or machine hours Specific allocation to departments, when use is limited to one application, such as payroll accounting.	Cost is apportioned to manufacturing, administration, selling and distribution divisions on the basis of service rendered to each.
Medical services including First-aid	Number of employees Number of casualties Wages of employees	The wages method is not an equitable method. The number of employees may be weighted with the casualty factor to give a more equitable basis.
Pattern making and drafting service	Man hours employed on pattern-making or drafting work Number of patterns	This may be treated as direct cost if pattern making is for a specific job, capital project, or research order.
Planning and progress and production control	Machine hours Direct labour hours	
Purchase Department	Value of materials purchased Number of orders placed	
Relining of furnaces	Allocated to the department where the furnace is located	Relining cost per unit of production is determined by dividing the estimated relining cost with the estimated units of production.
Rent and rates	Cubic capacity of building Value of buildings	
Royalties	Allocated direct to product, if paid on the basis of units produced Allocated to department if royalty is a lump-sum periodical payment	Royalty paid on the basis of units of production is a manufacturing cost ; if paid on the basis of sales, it is a selling cost.

<i>Items of cost</i>	<i>Basis of apportionment</i>	<i>Remarks</i>
Smithy and Carpenter Shop	Repair orders issued Repair labour hours Direct labour hours Machine hours	Prior to undertaking repairs, a repair order is issued which indicates the department for which repairs are undertaken. All labour and materials are booked to the repair order.
Supervisors	Number of employees Wages paid	Weightage is given for cost centres which require extensive supervision.
Telephone cost	Number of calls made Number of telephones Special survey of the use made of telephones	The basic periodical charge is apportioned on the basis of number of telephones.
Time office, Wages Office, and Personnel Department	Number of employees Wages paid Man-hours	
Tool room	Specific allocation on the basis of service rendered Direct labour hours	
Watch and Ward	Floor space area Value of buildings Value of materials	Weightage is given for those cost centres which require stricter security measures.
Welfare measure	Number of employees	
Recreation	Wages paid	
Work study (also time study and rate setting)	Number of studies made Number of employees Study man hours	

Absorption of Overhead in Costs. We have so far discussed the methods followed for allocation and apportionment of overhead costs to producing cost centres. The next step in the accounting of manufacturing overhead is to recover it in the cost of production. All products, jobs, processes, or services pass through one or more producing cost centres. The overhead expenses pertaining to a cost centre are ultimately charged to or absorbed in the cost of the products, jobs, etc. passing through it in such a manner that the cost of each unit of production of the cost centre includes an equitable share of the total overhead of that cost centre. This method of apportionment of the overhead expenses of the cost centres to cost units is known as *overhead absorption*. This is also referred to as *levy*, *recovery*, or *application of overhead*.

Overhead Absorption Rates. For the purpose of absorption of overhead in costs of jobs, processes, or products, overhead rates related to suitable factors or bases are determined. There are several methods in use for determining overhead rates ; these are discussed later in this chapter. The basic procedure in all these methods is to divide the amount of overhead expenses by the total number of units of the base selected, such as units of products, direct labour cost, labour hours, machine hours, or direct material cost. The rate so obtained is multiplied to the

units of the base contained in each individual product, job, etc. in order to arrive at the cost of each unit of outturn. This is illustrated below :

$$\text{Overhead rate} = \frac{\text{Overhead expenses}}{\text{Total quantum of base (quantity or value)}}$$

Overhead absorbed in a product = Overhead rate \times units of the base contained in the product

The main *objectives* of fixation of overhead rates are :

- (i) Absorption of overhead to cost units on a logical and equitable basis.
- (ii) Smoothing out of month-to-month fluctuations in the overhead cost per unit.
- (iii) Prompt compilation of cost on completion of production.
- (iv) Estimation of overhead cost in advance of production.
- (v) Prompt computation of cost of work-in-progress.

Actual and Pre-determined Overhead Rates. The overhead rate may be computed either on the actual (i.e. historical) or predetermined basis.

Actual Rate. Actual rate is obtained by dividing the overhead expenses incurred during the accounting period by the actual quantum (quantity or value) of the base selected. As the rates are worked out on a monthly basis the formula is :

$$\text{Overhead rate (actual)} = \frac{\text{Actual overhead expenditure during a month}}{\text{Actual quantity or value of the base related to the total production in the month}}$$

The basic principle in costing is to charge expenses directly to products, jobs, operations, processes, etc., as far as practicable. Recovery of overhead should, therefore, be made on actual basis. Due to the reasons mentioned below, it is, however, not always desirable to adopt, in practice, the actual rate for recovery.

- (i) The actual rate can be determined only after a period is over, when the relevant data regarding the expenses incurred and the quantum of the base for recovery are available. This results in delay in determination of the cost of products.
- (ii) The incidence of some of the items of overhead expenses like repairs, maintenance and overhauls of plant, machinery, and buildings, leave and holiday pay for workers, and overtime premium is not uniformly spread over all the accounting periods. Certain other payments like insurance premium, rent, etc. are made only periodically. The actual volume of activity is affected by seasonal and cyclic factors, and as the number of days in each calendar month is not uniform, the actual overhead cost varies from month to month. Due to the above mentioned factors, the actual rate of overhead absorption is liable to wide fluctuations, thus making cost comparison from period to period difficult.

The fluctuations in the actual overhead rates that may occur from month to month in a seasonal factory are illustrated in Fig. 4.9. The actual rates vary widely from Re. 0.50 to Rs. 2.00 per unit depending upon the volume of activity in the various months. A

predetermined rate of Re. 0.724 per unit determined with reference to the total normal overhead cost for the year as a whole would smoothen the seasonal fluctuations.

Month	Production units	Overhead cost	Actual overhead rate per unit	Pre-determined overhead rate based on the normal, taken for the whole year
		Rs.	Rs.	Rs.
Jan.	500	1,000	2.00	
Feb.	500	1,000	2.00	
Mar.	2,000	1,500	.75	
Apr.	3,000	2,000	.67	
May	3,500	2,100	.60	
June	4,000	2,000	.50	
July	4,000	2,000	.50	
Aug.	3,000	2,000	.67	
Sep.	2,500	1,500	.60	
Oct.	1,000	1,000	1.00	
Nov.	500	1,000		
Dec.	500	1,000		
Total	25,000	18,100		Re. 0.724

Fig. 4.9. Actual and Predetermined Overhead Rates in a Seasonal Factory

- (iii) Actual costs are used when they are compared with predetermined figures for the purpose of control. Costs serve as tools for managerial control when they point out the variations from the established norms. Actual overhead rates do not provide any such basis for cost control.

Pre-determined Rate. Pre-determined rate is computed by dividing the budgeted overhead expenses for the accounting period by the budgeted base for the period :

$$\text{Overhead rate (pre-determined)} = \frac{\text{Budgeted overhead expenses for the period}}{\text{Budgeted base for the period}}$$

To be of practical use, cost data must be furnished to the management with the utmost promptitude. The method of computation of overhead rate on a predetermined basis is useful in this regard as the rate pertaining to a period is available for the costing of jobs, products, etc. well in advance. This also enables prompt preparation of cost estimates and quotations, and fixation of selling prices. For prompt billing on a provisional basis before completion of work, as for example in the case of cost plus contracts, predetermined overhead rates are particularly useful. In concerns having a system of budgetary control of overhead expenses, no extra clerical work is involved in the computation of predetermined overhead rates in as much as the basic data needed, viz. the budgets for the expenses and the budgeted level of production activity (if normal activity or capacity is taken) are already available. While many undertakings have a system of budgets, overhead rates may be computed even without the help of budgets, by estimating or anticipating the overhead cost and the base.

Moving Average Rate. Another method of computation of overhead rate, known as the moving average method, is a compromise between the actual and predetermined methods. The moving average rate is determined on a monthly basis and is obtained by dividing the average of the past twelve or six months' actual overhead costs by the estimated base for the following month. For example, in computing machine hour rate for application in the month of August, the monthly average of the expenditure incurred for the period from the month of August of the previous year to the month of July in the current year is divided by the estimated machine hours for the month of August. Although the moving average rate removes to some extent the shortcomings of the overhead rate fixed on actual basis by equating the wide fluctuation, it cannot altogether avoid them. Further, in case of a change in the production activity associated with a heavy increase or decrease in the overhead costs, recovery on the basis of past actuals would result in excess or less charging of overhead to cost of production as the estimated expenses for the ensuing period are not taken into account.

Frequency of Rate Revision. With regard to the period of accounting of overhead, or in other words, the frequency of determination or revision of the overhead rate, it varies and rates may be computed on annual, half-yearly, quarterly, or monthly basis. In some concerns, the overhead rates are valid for periods longer than a year whereas in some others, this period may even be less than a month. Both long and short periods have their distinct advantages and shortcomings. We have seen how certain items of overhead cost fluctuate widely from month to month. The base used for computing the rate is linked with the production activity and it also varies abnormally from month to month in seasonal factories. In all such cases, a longer accounting period like a year adopted for working out the overhead rate, smooths out fluctuations and stabilises or 'normalises' the costs. At the same time, a long period rate is less expensive to operate. On the other hand, changing the rates at shorter intervals ensures accuracy, particularly when there are frequent changes in the pattern of the overhead expenses and the base to which the rate is related.

Blanket (Single) and Multiple Rates. A single overhead rate may be computed for the entire factory. This is known as the *Blanket rate*.

$$\text{Blanket rate} = \frac{\text{Overhead cost for the entire factory}}{\text{Total quantum of the base selected}}$$

The other method which is more commonly used is to determine *Multiple rates*, i.e. a number of separate rates :

- (a) For each producing department ;
- (b) For each service department ;
- (c) For each cost centre ;
- (d) For each product or product line ;
- (e) For each production factor ; for example, a separate rate may be determined for the overhead related to materials such as material purchasing, handling, storage, and upkeep costs, another rate may be determined for the overhead related to labour and a third one for that related to facilities, e.g. machine hour rate.

(f) For fixed overhead and variable overhead.

The multiple rates are worked out according to the following formula :—

Overhead rate

$$= \frac{\text{Overhead cost allocated and apportioned to each department, cost centre, or product}}{\text{Corresponding base}}$$

The number of overhead rates that a firm may compute would be fixed after taking into consideration the two opposing factors, viz. clerical costs involved and the degree of accuracy desired.

Blanket rates may be applied suitably in small firms and only where one single product is manufactured, particularly in a chain of continuous processes or where all the products pass through all the departments or operations uniformly and the incidence of overhead expenses is uniform or similar in all the departments.

Blanket rates are easy to compute and need little clerical time to operate but they have very limited use. The *disadvantages* of blanket rates are given below :

- (i) The use of blanket rate gives erroneous and misleading results where several products passing through a number of different producing departments are manufactured. The blanket rate ignores the position that each producing department has a distinct *factor* on account of which, the structure and the amount of overhead expenses, and the product bases and the productive time for different products in each department differ. The distortion of cost when a blanket rate is adopted is illustrated below :

Department	Direct labour	Overhead	Overhead rate	
	Rs.	Rs.	%	
A	20,000	2,000	10	Departmental rates
B	12,000	6,000	50	
C	8,000	12,000	150	
	Rs. 40,000	Rs. 20,000	50%	Blanket rate
			$\left[\frac{\text{Rs. 20,000}}{\text{Rs. 40,000}} \times 100 \right]$	

Assuming that two products, X and Y are manufactured, each of which passes through only one department, viz. A and C respectively, the costs under the two methods will be as follows :—

	Departmental rates		Blanket rate	
	Product X	Product Y	Product X	Product Y
	Rs.	Rs.	Rs.	Rs.
Direct material	200	150	200	150
Direct labour	400	200	400	200
Overhead	40	300	200	100
	640	650	800	450

The inflation of the cost of product X under the blanket rate method is due to the fact that it has to bear unnecessarily, a share of the high overhead costs of departments B and C. Similarly, the understatement of cost of product Y is the result of a part of the overhead cost of department C having been applied to other products which might have passed through departments A and B. The position becomes all the more anomalous if we assume that one of the departments is predominantly a machine section, so that the machine hour rate would have been more appropriate than the direct labour percentage method for recovery of overhead or that one department employs a highly sophisticated plant whereas another department has only ordinary machines,

- (ii) With a blanket rate, satisfactory managerial control is not possible because the performance of individual departments cannot be properly assessed.
- (iii) Adoption of blanket rate may render the valuation of work-in-progress erroneous. Where the product is yet to pass through certain departments before completion, addition of overhead at a blanket rate saddles the value of the work-in-progress with the cost of facilities not used.

Methods of Absorption. The various methods of determining overhead rates are discussed below. For the purpose of illustration, it has been assumed that in all the cases discussed, the rates are predetermined for each producing department or cost centre and that separate rates are determined for fixed and variable overhead costs.

1. Rate per Unit of Output or Production. This is a simple, direct, and easy method and is most suitable for mining and other extractive industries, foundries, brick laying, shoe industry, etc. where the output of a cost centre for which the overhead rate is required to be computed can be measured in convenient physical units such as units, volume, etc. This method is also suitable for firms producing a single product sold in containers of different sizes which can be easily differentiated by weight. To obtain the recovery rate, the total budgeted overhead expenses for a period, allocated and apportioned to the cost centre, are divided into the total physical units of production of that centre during the period, as illustrated below :

Department : Light Foundry	Month : July 19..
Overhead expenses (Budgeted)	Rs. 50,000
Budgeted production	1,000 tonnes
Overhead rate = $\frac{\text{Overhead expenses (budgeted)}}{\text{Budgeted production}}$	$\frac{\text{Rs. 50,000}}{1,000 \text{ tonnes}}$ = Rs. 50 per tonne

Each tonne of steel produced in the Light Steel Foundry during July will, therefore, bear an overhead cost of Rs. 50.

(If operating budgets are not set, anticipated overhead and output may be taken instead of budgeted overhead and output.)

The unit rate method is restricted to concerns which produce only one item of product, or a few sizes, qualities, or grades of the same product, if they can be equated to common units. In the latter case, overhead expenses may be recovered from the cost of the various products by expressing dissimilar units against a common denominator on weightage or points basis.

The method is illustrated in the example given below :

EXAMPLE 4.5.

X, Y and Z Ltd. manufacture a number of sizes of product P. They have grouped various sizes into four main groups called A, B, C and D groups. If the company manufactures only one group in the factory, the monthly production can be either 5,000 of A group, 10,000 of B group, 15,000 of C group, or 30,000 of D group. From the following information you are required to find the profit/loss made on each group of product showing prime cost, works cost, and total cost.

Product group	A	B	C	D
Actual production during a month (Nos.)	675	1,800	4,050	9,450
Cost :	Rs.	Rs.	Rs.	Rs.
Direct labour	3,000	5,500	7,500	21,000
Direct material	3,500	6,500	9,500	27,500
Sale price per unit	30	20	15	12

Overhead expense for the month is Rs. 81,000. Selling and distribution cost is to be calculated @ 10% of works cost. Overhead expenses are to be allocated to each product on the basis of number of units produced.

(I. C. W. A., Inter)

ANSWER :

As the four groups are not uniform, the overhead cost is apportioned by assigning points to the products in each group.

5,000 units A = 10,000 units B 15,000 units C = 30,000 units D

i.e., 1 unit A = 2 units B = 3 units C = 6 units D

If, therefore, one point is assigned to each unit of product in group D, the points assigned to each unit in groups, A, B and C will be 6, 3, and 2 respectively. Actual production during the month may be converted into points as follows :—

Product group	A	6	✓	675	×	4,050	=	points
	B	3	✓	1,800	×	5,400	=	points
	C	2	✓	4,050	×	8,100	=	points
	D	1	✓	9,450	×	9,450	=	points

Total 27,000 points

The overhead expense of Rs. 81,000 is apportioned prorata to the above points, @ Rs. 3 per point (Rs. 81,000 ÷ 27,000), as follows :—

Group	A	4,050	×	Rs. 3	=	Rs. 12,150
	B	5,400	×	Rs. 3	=	Rs. 16,200
	C	8,100	×	Rs. 3	=	Rs. 24,300
	D	9,450	×	Rs. 3	=	Rs. 28,350

Rs. 81,000

(Solution to the latter portion of the example has not been given, being not relevant to the topic under discussion.)

2. **Direct Labour Cost (or Direct Wages) Method.** This is another simple and easy method that is widely in use. The total direct labour content of all the jobs or products in a cost centre during the accounting period is determined in terms of money value. The overhead recovery rate, expressed usually as a percentage, is computed by dividing the overhead expenses by the direct labour cost.

Overhead expenses (budgeted) Rs. 10,000

Direct labour (anticipated for the month) Rs. 20,000

Overhead rate = $\frac{\text{Overhead expenses}}{\text{Direct labour}} = \frac{\text{Rs. 10,000}}{\text{Rs. 20,000}} = 50\% \text{ of direct labour cost}$

The method is further illustrated below :

EXAMPLE 4.6.

A factory has (i) two production departments, (ii) two service departments, i.e. Electrical Department and Stores Department and (iii) one Administrative Department.

Following figures have been taken from the financial books :—

Stores and Spare Parts	Rs.
Opening Balance	2,00,000
Purchases during the year	1,00,000
Closing Balance	1,00,000

<i>Other items of expenditure</i>	<i>Rs.</i>
Power	1,00,000
Lighting	23,500
Fuel for Production Department A	50,000
General Miscellaneous Expenses	15,000
Maintenance and Repairs to Plant and Machinery	90,000
Maintenance and Repairs to Buildings	20,000
Wages of Direct Workers	6,00,000
Wages of Indirect Workers	1,20,000
Administrative Staff Salary	60,350
Depreciation on Plant and Machinery	3,00,000
Depreciation on Buildings	50,000
Loss of Raw Materials	50,000

Notes :

- (i) Maintenance and Repairs to Plant and Machinery of Rs. 90,000 include Rs. 40,000 for a thorough overhauling of a machine classified as major capital repairs.
- (ii) General Miscellaneous expenses of Rs. 15,000 include Rs. 6,600 for developing patent of a new item not produced during the year.
- (iii) Loss of Raw Material Rs. 50,000 includes Rs. 20,000 lost by fire covered by fire insurance policy and the balance represents normal storage losses. The insurance company pays only to the extent of 90% of the losses.
- (iv) Administrative Department receives least inter-departmental service from the other two service departments, i.e. Electrical and Stores Departments.
- (v) Electrical Department renders more service to other departments compared to what it receives.

Following additional information is supplied to you :—

Nature of expenses	Production Deptt. A	Production Deptt. B	Electrical	Stores	Administrative
	Rs.	Rs.	Rs.	Rs.	Rs.
Direct wages	2,00,000	4,00,000	..	..	..
Value of Plant and machinery commissioned	12 lacs	12 lacs	6 lacs	..	..
Capital Value of Buildings	4 lacs	3 lacs	6 lacs	0.75 lac	0.25 lac
Stores and Spare Parts consumption	50%	30%	20%	..	..
Power/Kwh	50,000	30,000	5,000	20,000	..
Lighting Units	10,000	6,000	3,000	5,000	2,500
Number of Personnel	400	300	200	100	50

You are required to work out the overhead rates of departments A and B expressed as percentages on direct labour up to one decimal point. (I. C. W. A., Inter—Adapted)

The answer to this example is given on Page 247.

The direct labour cost method of determination of overhead rates is suitable where direct labour constitutes a major proportion of the total costs and the rates of pay and the method of payment are the same for majority of the workers in the concern. In some concerns, expenses related to labour, e.g. fringe benefits are recovered by means of a separate overhead rate. Such a rate may appropriately

	Total	Production	Production	Electrical	Stores	Administrative	Basis of allocation
	Rs.	Department A	Department B	Rs.	Rs.	Department	Rs.
Store and Spare Parts							
Opening balance Rs. 2,00,000							
Add Purchases Rs. 1,00,000							
Less Closing balance Rs. 1,00,000							
Power	2,00,000	1,00,000	60,000	40,000	—	—	Percentage fixed
Lighting	1,00,000	50,000	30,000	—	20,000	—	Kwh excluding Electrical Deptt.
Fuel	23,500	10,000	6,000	—	5,000	2,500	Lighting units excluding Elec. Deptt.
General Misc. Expenses	50,000	50,000	—	—	—	—	Direct to Production Deptt. A
(Rs. 15,000 minus Rs. 6,600)							
Maint. & repairs to P & M	8,400	3,200	2,400	1,600	800	400	Personnel employed
(Rs. 90,000 minus Rs. 40,000)							
Maint. & repairs to Buildings	50,000	20,000	20,000	10,000	—	—	Value of P & M
Wages of Indirect workers	20,000	8,000	6,000	4,000	1,500	500	Value of building
	1,20,000	48,000	36,000	24,000	12,000	—	Personnel employed excluding Administration
Administrative Staff salary	60,350	—	—	—	—	60,350	Direct
Depreciation P & M	3,00,000	1,20,000	1,20,000	60,000	—	—	Value of P & M
Depreciation on Buildings	50,000	20,000	15,000	10,000	3,750	1,250	Value of building
Loss of raw materials							
Rs. 50,000 less Rs. 20,000 plus 10% of Rs. 20,000)	32,000	—	—	—	32,000	—	Direct to Stores building
	10,14,250	4,29,200	2,95,400	1,49,600	75,050	65,000	
		26,000	19,500	13,000	6,500	(—) 65,000	Personnel employed
		40,775	24,465	16,310	81,550	—	Consumption of Stores & Spares
				1,78,910	(—) 81,550		
		1,11,819	67,091	(—) 1,78,910			Power
		6,07,794	4,06,456				
		303.9 %	101.6 %				

Overhead percentage on direct labour

Note : In actual practice, pre-determined overhead rates are suitably rounded off in order to simplify the calculation work involved in the levy of the rates to cost units. In the example given above, the rates could be taken as 300% and 100% for Departments A and B respectively.

be worked out and applied on the basis of direct labour cost. The main advantage of the method lies in the fact that no basic data are required to be specially worked out or maintained because the main information, i.e. the direct labour cost is even otherwise available in the wage analysis statement.

The defects and limitations of this method are as follows :--

- (a) Where labour is not the main factor of production, absorption of overhead is not equitable. Important factors like extensive use of plant and equipments are ignored.
- (b) The method is not suitable where piece-workers are employed because the same amount of overhead will be applied to a job irrespective of whether it is completed by an efficient worker in a shorter time or by a slow worker who takes more time
- (c) The shortcoming of this method becomes apparent when we come across cases where the same operation is performed on different jobs by operatives with varying rates of pay and where it is not possible for the high rated operatives to increase productivity or save time through increased effort or efficiency. The operations performed by the high rated operatives not only cost more in labour but also have a larger share of the overhead expenses as compared to those performed by low rated workers having the same efficiency. As a matter of fact, high rated workers should normally take less time, make use of less power, tools, supplies, etc. and should need less supervision so that the amount of overhead chargeable to the job done by them should also be less. The difficulty may to some extent be obviated by determining an overhead rate based on the average wage rate of all the workers employed on a job or in a department.
- (d) The method ignores the function of time. Most of the overhead expenses like rent, taxes, supervision, power, lighting, depreciation, etc. accrue on the basis of time. Direct labour cost is, therefore, not a true measure for determining the extent to which such services are utilized by the various products.

3. *Direct Labour Hours or Production Hours Method.* The rate is determined by dividing the overhead expenses by the aggregate of the productive hours of direct workers. Assuming the data given in Example 4.2, the rate will be determined as follows :—

	Shop No 1	Shop No. 2	Shop No. 3
Budgeted overhead expenses	Rs. 32,536	Rs. 43,954	Rs. 16,710
Budgeted direct labour hours	1,50,000	1,50,000	1,00,000
Overhead rate for Shop No. 1 =	Overhead expenses Direct labour hours	Rs. 32,536 1,50,000	
	= Re. 0.2169 per labour hour		

Similarly for Shops Nos. 2 and 3, the rates will be Re. 0.2930 and Re. 0.1671 per labour hour respectively.

The method is further illustrated below with the help of some examples.

EXAMPLE 4.7.

Every quarter, a manufacturing company with four productive departments calculates

departmental overhead rates per direct labour hour based on the actual expenditure incurred during that quarter. The results during a year were as follows :—

	Quarter	Deptt. A Rs.	Deptt. B Rs.	Deptt. C Rs.	Deptt. D Rs.
Variable overhead rate		3	4	6	5
Fixed overhead rate	1	4	6	3	7
	2	6	6	4	8
	3	5	5	4	10
	4	3	7	6	5
	Quarter	Deptt. A (‘000)	Deptt. B (‘000)	Deptt. C (‘000)	Deptt. D (‘000)
Hours worked	1	32	50	60	48
	2	40	50	56	36
	3	36	32	52	26
	4	36	28	48	40

The manufacturer dissatisfied with the results produced, asks you to calculate overhead rates which take account of accrued overhead. The proportion of total annual fixed overhead to be charged to each department is, A : 20% ; B : 40% ; C : 15% ; D : 25%. You are required to prepare annual overhead rates per direct labour hour correct to the nearest half-rupee for each department combining fixed and variable portions (I C. M. A., Inter—Adapted)

ANSWER :

Total fixed overhead for the year is the aggregate of the products of labour hours for each department for each quarter and the corresponding fixed overhead rates. This comes to Rs 35,96,000. Apportionment of annual fixed overhead cost to departments is as follows :

Deptt. A	Rs. 7,19,200	(20%)
Deptt. B	Rs. 14,38,400	(40%)
Deptt. C	Rs. 5,39,400	(15%)
Deptt. D	Rs. 8,99,000	(25%)
	<u>Rs. 35,96,000</u>	

Overhead rates per direct labour hour will be as follows :—

	Fixed	Variable	Total
Deptt. A	Rs. 7,19,200 =Rs. 5	Rs. 3	Rs. 8
	*1,44,000		
B	Rs. 14,38,400 =Rs. 9	Rs. 4	Rs. 13
	*1,60,000		
C	Rs. 5,39,400 =Rs. 2.5	Rs. 6	Rs. 8.5
	*2,16,000		
D	Rs. 8,99,000 =Rs. 6	Rs. 5	Rs. 11
	*1,50,000		

*Total hours worked in the departments during the year.

EXAMPLE 4.8.

The initial budget for a company with four departments should be the following :—

Department	Overhead allocation direct	Overhead apportioned	Direct labour hours
	Rs.	%	
1	14,200	10	60,000
2	7,200	30	2,00,000
3	16,400	20	1,20,000
4	22,600	40	1,50,000
	<u>Rs. 60,400</u>	<u>Rs. 1,76,000</u>	<u>5,30,000</u>

OVERHEAD COSTS

It was decided that a new department (5) should be established and the others slightly reorganised. The following alterations to the budget were agreed :—

- (a) Rs. 15,000 additional overhead to be allocated directly to department (5).
 (b) Rs. 6,600 of overhead previously allocated directly to department (3) to be transferred to department (5)

- (c) Rs. 30,000 additional overhead to be apportioned thus :

Department	1	2	3	4	5
Proportion	10%	20%	—	10%	60%

- (d) Revised direct labour hours expected are

Department	1	2	3	4	5
Hours	69,600	2,40,000	1,00,000	1,60,000	90,000

You are required to calculate

- (i) the departmental direct labour hour rates of overhead based on the preliminary budget;
 (ii) the departmental direct labour hour rates of overhead based on the revised budget ,
 (iii) the overhead chargeable on the revised rates to one dozen of product AB on the manufacture of which the following hours per dozen are spent in each department

Department	1	2	3	4
Hours	6	4	8	3

(I C M A , Inter—Adapted)

ANSWER :

- (i) Departmental overhead rates based on the preliminary budget are

Deptt.	Allocated overhead	Apportioned overhead	Total overhead	Direct labour hours	Direct labour hour rate
(i)	(ii) Rs.	(iii) Rs.	(iv) Rs.	(v) Rs.	(iv)÷(v) Rs.
1	14,200	17,600	31,800	60,000	0.53
2	7,200	52,800	60,000	2,00,000	0.30
3	16,400	35,200	51,600	1,20,000	0.43
4	22,600	70,400	93,000	1,50,000	0.62
	<u>Rs. 60,400</u>	<u>Rs.1,76,000</u>	<u>Rs.2,36,400</u>	<u>5,30,000</u>	

- (ii) Departmental overhead rates based on the revised budget will be :

Deptt.	Total Overhead (Preliminary budget) Rs.	Total Overhead (Revised budget) R	Revised direct labour hours	Revised direct labour hour rate Rs.
1	31,800	(31,800 + 3,000) = 34,800	69,600	0.50
2	60,000	(60,000 + 6,000) = 66,000	2,40,000	0.275
3	51,600	(51,600 - 6,600) = 45,000	1,00,000	0.45
4	93,000	(93,000 + 3,000) = 96,000	1,60,000	0.60
5	—	(15,000 + 6,600 + 18,000) = 39,600	90,000	0.44
	<u>Rs.2,36,400</u>	<u>Rs. 2,81,400</u>		

(iii) Overhead chargeable on one dozen of product AB will be :

Deptt. 1 : $6 \times \text{Rs. } 0.50$	= Rs. 3.00
2 : $4 \times \text{Rs. } 0.275$	= Rs. 1.10
3 : $8 \times \text{Rs. } 0.45$	= Rs. 3.60
4 : $3 \times \text{Rs. } 0.60$	= Rs. 1.80

Total Rs. 9.50

The *advantages* of the direct labour hour method are as follows :—

- It is largely suitable where labour constitutes the major factor of production.
- The rate fully takes into account the time factor.
- The rate is not affected by the method of wage payment or the grade or rate of pay of the workers.

The *disadvantages* are :

- Like the direct labour cost method, this method does not take into account factors of production other than labour. This sometimes leads to faulty distribution of overhead to product cost. In a machine shop, for instance, where different types of machines are in use, it will not be correct to recover departmental overhead on the basis of labour hours. Similarly, recovery of material handling and upkeep expenses on the basis of production labour hours will not be appropriate and for such expenses a separate overhead rate may be calculated.
- Many concerns do not maintain any record of time taken on job cards. This is particularly so where wage payments are not related to either the attendance or the time taken for production, as for example in the piece-work system. More clerical effort is, therefore, required in determining the overhead rate because labour time has to be specially recorded to meet the requirements of this method.

Machine Hour Rate. This method of absorption of overhead is applicable where work is performed predominantly on machines. The hourly machine rate is usually computed departmentwise. A single machine rate to cover the entire factory is unsuitable because different types of machines may be in use in the various producing departments. More than one rate may be computed in a department, one for each machine or a group of machines which are similar to one another as regards their make, type, size or capacity, wattage, horse-power, and such other technical factors. In such cases each machine or a group of machines constitutes a cost centre for the purpose of the overhead expenses.

Every job or product passing through a machine cost centre bears a share of the overhead, the amount of which depends upon the time it takes on the machines. The machine hour rate is determined by dividing the overhead costs pertaining to the machine cost centre by the number of effective machine hours likely to be worked during a period. The overhead costs consist of the indirect expenses allocated and apportioned to the particular machine cost centre for which the machine hour rate is to be determined. The machine hours are determined in the same manner as direct labour hours, i.e. by aggregating the effective running hours of each machine for the accounting period.

If the budgeted overhead expenses for a month are Rs. 6,000 and the anticipated effective machine hours are 3,000 for the period,

$$\text{Machine hour rate} = \frac{\text{Rs. 6,000}}{3,000} = \text{Rs. 2 per hour}$$

Machine hour rates may be computed separately for the fixed and variable expenses. This would enable the loss due to non-utilisation of machines being conveniently worked out.

The examples given below illustrate the method of calculation of machine hour rate. Fig. 4.10 shows a machine hour rate computation chart.

EXAMPLE 4.9.

The budgeted working conditions for a cost centre are as follows :—

Normal working week	42 hours
Number of machines	14
Normal weekly loss of hours on maintenance etc.	5 hours per machine
Estimated annual overhead	Rs. 1,61,616
Estimated direct wages rate	Rs. 3 per hour
Number of weeks worked per year	48

Actual results in respect of a 4-week period are,

Overhead incurred	Rs. 13,270
Wages incurred	Rs. 7,620
Machine hours worked	2,100

You are required to calculate (a) the overhead rate per machine hour and (b) the amount of under- or over-absorption of both wages and overhead (I C W A, Inter—Adapted)

ANSWER :

(a) Normal working hours per year	= 14 (machines) × 42 (hours per week) × 48 (weeks) = 28,224 hours
Normal loss of hours per year	= 14 × 5 × 48 = 3,360 hours
Effective hours per year	= 28,224 – 3,360 = 24,864
Machine hour rate	= $\frac{\text{Rs. 1,61,616}}{24,864}$ = Rs. 6.5
(b) Overhead absorbed = 2,100 hours @ Rs. 6.5	= Rs. 13,650
Overhead incurred	= Rs. 13,270
Overhead over-absorbed	= Rs. 380
Wages absorbed = 14 × 42 × 4 hours @ Rs. 3 per hour	= Rs. 7,056
Wages incurred	= Rs. 7,620
Wages under-absorbed	= Rs. 564

EXAMPLE 4.10.

A productive department of a manufacturing company has five different groups of machines, each of which it is desired to establish machine hour rates. A budget for this department for the year ending 30th June, 19. . shows the following overhead :—

Consumable supplies : Machine group		Rs.	Rs.
1		300	
2		600	
3		1,000	
4		1,200	
5		1,900	
			5,000

Maintenance : Machine group	1	700	
	2	800	
	3	1,200	
	4	1,700	
	5	1,000	
			5,400
Power	..		1,400
Rent and rates	..		4,800
Heat and light	..		800
Insurance of building	..		400
Insurance of machinery	..		1,000
Depreciation of machinery	..		16,000
Supervision	..		9,600
General expenses	..		1,200
			<u>Rs. 45,600</u>

Additional operating information is available as follows :—

Group	Effective H.P.	Area occupied Sq. metre	Book value of machinery (Rs.)	Machine working hours
1	10	50	5,000	24,000
2	40	150	25,000	40,000
3	20	20	10,000	16,000
4	50	100	15,000	20,000
5	80	80	20,000	60,000
	<u>200</u>	<u>400</u>	<u>Rs. 1,00,000</u>	<u>1,60,000</u>

You are required to :

(a) Calculate a machine hour rate for each of the five groups of machines. Show clearly the bases of apportionment that you use.

(b) Calculate the overhead that will be absorbed by one unit of product A and one unit of product B on the manufacture of which the following times (in hours) are spent, in the machine groups of this department :

Machine group	1	2	3	4	5
Product A (each unit)	2	—	7	1	2
Product B (each unit)	4	1	—	6	1

(I. C. W. A., Inter—Adapted)

ANSWER :

(a) The calculations of the machine hour rates are shown in Fig. 4.10.

(b) Absorption of overhead will be as follows :

	Product A	Product B
Group 1	2 × .2330	4 × .2330
2	—	1 × .3058
3	7 × .2998	—
4	1 × .4837	6 × .4837
5	2 × .2217	1 × .2217
	<u>Rs. 3.49</u>	<u>Rs. 4.36</u>

The machine hour rate of recovery of overhead costs has the undermentioned advantages :—

(a) It is a scientific, practical, and accurate method of recovery of overhead resulting in ascertainment of accurate and reliable costs.

MACHINE HOUR RATES					
	Basis of allocation	Total Rs.	Machine Group		
			2 Rs.	3 Rs.	4 Rs.
Consumable supplies Maintenance Power Rent & rates Heat & light Insurance —building Insurance —machinery Depreciation —machinery Supervision General expenses	Direct	5,000	600	1,000	1,200
	Direct	5,400	700	1,200	1,700
	H P. per machine-hour	1,400	42	56	175
	Area	4,800	600	240	1,200
	Area	800	100	40	200
	Area	400	50	20	100
	Book value	1,000	50	100	400
	Machine-hours	16,000	4,000	1,600	2,000
	Area	9,600	1,200	480	2,400
	Area	1,200	150	60	300
Machine working hours		Rs 45,600	Rs 5,592	Rs. 12,232	Rs. 9,675
Machine hour rates			24,000	16,000	20,000
			Re 0 2330	Re. 0 3058	Re. 0 4837
					Rs 13,305
					60,000
					Rs 0 2217

Fig 4 10 Machine Hour Rates

- (b) Cost reports are dependable so as to be of great assistance to the management in decision making.
- (c) It provides useful data for estimating cost of production, setting standards, and for fixing selling prices for quotations.
- (d) It provides a ready method for measuring the cost of idle machines if separate rates for fixed and variable overheads are calculated. When the hourly rate is determined on the basis of anticipated running hours of the machines, under-absorption of the fixed overhead expenses occurs if the actual running hours are less than the estimates. This under-absorption may partly represent the expenditure incurred on account of idle machines. This has been further discussed in a later section of this chapter.

The *limitations* of the machine hour rate are :

- (a) If hand labour is equally important and a large percentage of jobs are fabricated or processed by hand labour, this method will lead to inaccurate results. In order to obviate this difficulty, computation of a separate labour hour rate is desirable.
- (b) It often becomes difficult to estimate machine hours, particularly when the full production programme is not available in advance. Correct estimation of machine-hours is of vital importance ; otherwise, the method will give misleading results. This problem will not, however, arise if capacity other than the actual, viz. practical, maximum, or normal capacity is used.
- (c) Maintenance of detailed records for the running hours of machines and for the time taken for all operations on the various machines is essential. This tends to make operation of the method costly, particularly when a large number of machine hour rates are required to be determined to cater for all the machine cost centres in the factory.
- (d) As rates for individual machines or group of machines are to be determined, a blanket rate, even if feasible, cannot be used. This makes the method still more costly.

Several variations of the machine hour rate method, e.g. supplementary rate and composite rate methods are in use.

(i) *Supplementary rate* : Besides the machine hour rate, a supplementary rate (i.e. a separate or additional rate) is used to charge all the other overhead costs not included in the machine rate. For example, if the machine hour rate includes only the overhead directly allocated to the particular machine cost centre or which the rate has been computed, the share of cost of the other service sections apportioned to the cost centre is recovered through a separate rate, if a separate bench (or manual labour cost centre) exists. Supplementary rates may also be used for correcting any error in the determination of the machine hour rate due to which there is a heavy under- or over-absorption. The use of supplementary rates has been discussed later in this chapter.

(ii) *Composite or comprehensive rate* : Sometimes, the labour costs of the operatives who work on the machines are also included in the machine hour

rate. Thus, the wages and the overhead costs may be absorbed on the basis of a single composite rate. An illustration is given below :

EXAMPLE 4.11.

Following data are given to you from which you are required to calculate the composite machine hour rates of two production departments A and B. There are two service departments X and Y as well as an establishment department E. The data give the annual expense budgeted for the year in question.

<i>Expenditure</i>	<i>Total amount</i> Rs	<i>Remarks</i>
Establishment expenses	3,00,000	Distribute on the basis considered best by you.
Indirect labour	10,00,000	Allocate Rs 1,00,000 to each of the service departments and the balance to production departments on the basis of your choice, according to cost accounting principles
Electric power	70,000	Decision on the allocation to be taken by you as a cost accountant
Electric light	25,000	
Fuel consumption	1,00,000	Only department B consumes fuel
Repairs to plant and machinery		No remarks
Rent	1,00,000	Both for factory and office
Factory general expenses	95,000	Allocate as per floor space but not for office.

The following table is also supplied to you :

	Total	Production departments		Service departments		Establishment department
		A	B	X	Y	E
Floor space (Sq. ft.)	1,00,000	40,000	30,000	15,000	10,000	5,000
Horse-power rating ratio	—	4	2	1	—	—
Light points	50	30	12	3	3	2
Direct labour hours	4,20,000	2,00,000	1,50,000	50,000	20,000	—
Machine hours	2,00,000	1,00,000	80,000	20,000	—	—
Direct wages (Rs.)	10,00,000	5,00,000	3,00,000	1,52,500	47,500	—
Personnel employed	3,265	1,265	1,000	500	300	200
Value of plant and machinery (Rs.)	100 lacs	50 lacs	35 lacs	15 lacs	—	—
Value of building (Rs.)	19.75 lacs	10 lacs	6 lacs	3 lacs	0.50 lac	0.25 lac
Tools stock at purchase value (Rs.)	2.5 lacs	1.0 lac	1.0 lac	0.5 lac	—	—
Amortization of tools as a percentage on straight line method	—	25%	25%	25%	—	—
Depreciation on straight line method :						
Machinery	—	10%	8%	5%	—	—
Building	—	2%	2%	2%	2%	2%

Service department Y renders services to A, B and X departments. Service department X renders service to production departments only. Expenses apportioned to service department Y are to be distributed to service department X and production departments on the basis of direct labour hours. Expenses of service department X are to be distributed to production departments on the basis of machine hours.

Decimals to be ignored in all calculations.

(I. C. W. A., Inter)

Answer to this example is given on Page 258.

5. Direct Material Cost Method. In this method, the value of direct materials consumed in production is adopted as the base for the absorption of overhead costs. The rate, which is usually expressed as a percentage of direct material cost, is determined by dividing the total overhead by the aggregate of the cost of direct materials relating to all the products in the department. If for example, the budgeted overhead expense of a department is Rs. 5,000 and the estimated total direct material cost of all the outturn in the department is Rs. 20,000, the overhead rate will be :

$$\frac{\text{Overhead expenses (budgeted)}}{\text{Anticipated direct material cost}} = \frac{\text{Rs. 5,000}}{\text{Rs. 20,000}} = 25\% \text{ of direct material cost}$$

The *advantages* of this method are as follows :--

- (a) The cost of direct materials being readily available from the materials issues analysis, calculation of the rate is as simple as in the direct labour cost method and no additional records are required to be maintained
- (b) The method is more suitable when material prices are fairly stable and the material used or consumed per hour and the material mix are constant as is the case in some process industries, or where the direct material, both in quantity and cost, is uniform for all the products.
- (c) This is an equitable method for absorption of the overhead costs pertaining to upkeep and handling of materials. Any other base that may be adopted for the recovery of these costs will not be appropriate as it will have practically no relationship with the function performed. The method is to separate the storekeeping expenses from the rest of the overhead and to compute an additional or supplementary rate on the basis of direct material cost, for the absorption of such expenses. The usual procedure is to have a separate cost centre in the overhead distribution statement to which all store-keeping expenses are allocated or apportioned, and to work out a separate overhead rate for this centre.

The *shortcomings* of this method are as follows :--

- (a) The method is said to be illogical and inaccurate in as much as the incidence of overhead costs is not related to the cost of materials. A batch of products manufactured out of raw material of high price will cost more than another batch utilising low priced material, not only because the cost of material is high but also due to the fact that it is burdened with an undue share of the overhead cost. It is also likely that a product that needs relatively less productive effort but

ANSWER :
(4.11)

	Total Rs	Production Departments		Service Departments		Establishment Department Rs.
		A Rs.	B Rs.	X Rs.	Y Rs.	
Direct wages	10,00,000	5,00,000	3,00,000	1,52,500	47,500	—
Establishment expenses	3,00,000	—	—	—	—	3,00,000
Indirect labour	10,00,000	5,00,000	—	1,00,000	1,00,000	—
Electric power	70,000	40,000	20,000	10,000	—	—
Electric light	25,000	15,000	6,000	1,500	1,500	1,000
Fuel consumption	1,00,000	—	1,00,000	—	—	—
Repairs to plant and machinery	1,00,000	50,000	35,000	15,000	—	—
Rent	1,00,000	40,000	30,000	15,000	10,000	5,000
Factory general expenses	95,000	40,000	30,000	15,000	10,000	—
Tool amortization	62,500	25,000	25,000	12,500	—	—
Depreciation : Machinery	8,55,000	5,00,000	2,80,000	75,000	—	500
Building	39,500	20,000	12,000	6,000	1,000	—
Personnel employed	37,47,000	17,30,000	11,38,000	4,02,500	1,70,000	3,06,500
		1,26,500	1,00,000	50,000	30,000	(—) 3,06,500
Direct labour hours		1,00,000	75,000	25,000	2,00,000	(—) 2,00,000
Machine hours		2,65,275	2,12,225	4,77,500	(—) 4,77,500	
		22,21,775	15,25,225			
		÷	÷			
Machine hour rate		1,00,000	80,000			
		= Rs 22 22	= Rs 19 07			

the material cost of which is very high, will bear a high proportion of the overhead costs.

- (b) The method becomes all the more inequitable if the raw materials in a product do not pass through all the processes or operations, or where some of the materials pass through all the processes and the rest through some of the processes only.
- (c) The method, like the direct labour cost method, ignores the important factor of time.

6. *Prime Cost Method.* The base adopted in this method is the prime cost, i.e. the aggregate of the direct labour and direct material costs of all the products of the cost centre for which the recovery rate is required to be worked out. If the budgeted overhead expenses are assumed to be Rs. 45,000 and the estimated direct labour and direct material costs are Rs. 20,000 and Rs. 25,000 respectively, the rate will be calculated as follows :—

$$\text{Overhead recovery rate} = \frac{\text{Budgeted overhead expenses}}{\text{Anticipated direct labour and direct material}}$$

$$\frac{\text{Rs. 45,000}}{\text{Rs. 20,000} + \text{Rs. 25,000}} = 100\% \text{ of prime cost}$$

Another example showing the method of calculation of overhead rate under this method and its comparison with the rates obtained under the other methods, is given below :

EXAMPLE 4.12

The following information relates to the activities of a production department of a factory for a certain period :—

Direct materials used	Rs. 4,000	
Direct wages	Rs. 6,000	
Direct labour worked	24,000	(including 20,000 hours of machine operation)
Overhead chargeable to the department	Rs. 5,000	
For Order No. 156 carried out in the department, the relevant data were :		
Direct materials used	Rs. 200	
Direct wages	Rs. 165	
Direct labour hours	820	(including 800 machine hours)

You are required to calculate the overhead chargeable to Order No. 156 by four different cost rates. (The rates you select should be between them, utilize all the data shown above in connection with Order No. 156.)
(I. C. M. A., Inter—Adapted)

ANSWER :

The charge to Order No. 156 under each of the methods previously discussed will be as follows :—

(a) Prime cost method : Overhead rate = $\frac{\text{Rs. 5,000}}{\text{Rs. 10,000}} = 50\% \text{ of prime cost}$

Charge to Order No. 156 = 50% of (Rs. 200 + Rs. 165) = Rs. 182.50

(b) Direct material cost method : Rate = $\frac{\text{Rs. } 5,000}{\text{Rs. } 4,000} = 125\%$ of direct material cost

Charge = 125% of Rs. 200 = Rs. 250

(c) Machine hour rate basis : Rate = $\frac{\text{Rs. } 5,000}{\text{Rs. } 20,000} = \text{Rs. } 0.25$ per hour

Charge = Rs. 0.25 \times 800 = Rs. 200

(d) Direct labour hour basis : Rate = $\frac{\text{Rs. } 5,000}{\text{Rs. } 24,000} = \text{Rs. } 0.2083$ per hour

Charge = Rs. 0.2083 \times 820 = Rs. 170.81

(e) Direct labour cost method : Rate = $\frac{\text{Rs. } 5,000}{\text{Rs. } 6,000} = 83\frac{1}{3}\%$ of direct labour cost

Charge = $83\frac{1}{3}\%$ of Rs. 165 = Rs. 137.50

The prime cost method of recovery of overhead cost is a simple one and easy to operate. The data required for the base, i.e. direct labour and direct material costs are readily available in the costs records. The method is, however, not widely used because :

- (i) It combines the shortcomings of both the direct labour and the direct material methods ;
- (ii) Labour is not a factor ;
- (iii) It gives equal importance to both material and labour in the computation of the overhead rate although overhead costs are related more to labour costs than material costs and if the material content of a job is high, this would give undue weightage to the material cost factor, as will be seen from the following illustration :

	Job 1	Job 2
	Rs.	Rs.
Direct material ..	100	50
Direct labour, Re. 1 per hour ..	50 (50 hrs.)	100 (100 hrs.)
Prime cost ..	150	150
Overhead, 100% of prime cost ..	150	150
Total cost ..	300	300

It will be seen that although Job 2 takes twice as much time as Job 1, the same amount of overhead is charged to each job.

7. Sale Price Method. The base adopted for calculating the overhead rate under this method is the estimated sale price of all the units of production :

$$\text{Overhead rate} = \frac{\text{Budgeted overhead expenses}}{\text{Sale price of units of production}}$$

As overhead costs have practically no relationship with the sale price of the products, the method is mostly arbitrary, and the recovery of overhead in the cost of the various products is not equitable. The application of overhead is more on the basis of the benefits, i.e. the revenue brought in by the products rather than on their ability to bear the costs.

The sale price method may, however, be found suitable for the allocation of administration, selling, and distribution costs to products.

In some other situations, not directly relating to absorption of overhead, the sale price method may be used, e.g.,

- (i) For the application of research, development, and product design costs. Such portions of these costs which cannot be related directly to products or product lines may be prorated on the basis of sale price of each product.
- (ii) For the proration of joint product costs.

Composite Labour and Overhead Rate. Instead of computing a rate for absorption of overhead costs alone, a composite cost rate comprising both the labour and overhead costs may be worked out. If operation hours are taken as the base, the composite rate for a cost centre will denote the cost per hour of the use of all the facilities of the centre. This rate when applied to the hours taken up by a cost unit gives the conversion cost of the unit. The formula for the method may be expressed as follows : --

$$\text{Conversion cost rate} = \frac{\text{Budgeted direct labour} + \text{budgeted overhead}}{\text{Estimated operation hours}}$$

It may be noted that conversion cost is the production cost excluding the cost of direct materials (but including the cost resulting from variations in direct material in weight or volume) of product, partly or fully finished products. In other words, conversion cost of a finished product or work-in-progress is comprised of direct labour and the manufacturing overhead.

Overhead Rates for Service Cost Centres. Overhead rates are fixed usually for producing cost centres only. The cost of the service departments are apportioned to the producing departments and are thus included in the overhead rates fixed for the latter. Sometimes separate overhead rates may be fixed for service departments as well. The rates so determined may be used for the absorption of the service department costs to cost units.

Necessity for a separate rate for a service department for charging the expenses to cost of production arises : (i) when the base adopted for the recovery of overhead in a producing department is not suitable for the absorption of the cost of the particular service department and (ii) when a service department partly functions as a producing department. As already mentioned, material storage and handling costs may not appropriately be absorbed at rates ordinarily determined for producing departments such as on the basis of direct labour hours, machine hours, etc. A separate overhead rate is, therefore, fixed for the absorption of materials storage and handling cost centre etc., on the basis of the value of direct materials consumed. Similar rates may also be fixed for the Tool Room, Inspection, and Packing Department. The method adopted for the allocation and apportionment of the costs of partly service and partly producing centres was discussed earlier. The costs of such centres are suitably apportioned to the service and manufacturing portions of the centre and separate rates are determined for each of the two functions.

Choice of an Overhead Rate. The method adopted for overhead absorption varies from one industry or concern to another. Many firms classify and subdivide

the manufacturing overhead expenses into several types and use separate overhead rates for each type.

Selection of the most equitable method is of paramount importance since a method that is not suitable will distort costs and thus make them useless for control and decision making purposes. The particular method or methods selected for application in a firm would depend upon the factors mentioned below.

- (i) Type of industry.
- (ii) Nature of products and processes of manufacture.
- (iii) Nature of the overhead expenses.
- (iv) Organisational set-up of the undertaking into departments and/or cost centres.
- (v) Individual requirements with regard to the circumstances prevailing.
- (vi) Policy of the management.
- (vii) Accuracy vis-a-vis cost of operating the method. Some of the methods are comparatively more accurate and provide equitable bases for overhead absorption but they are expensive as they require additional clerical efforts. Whether or not the accuracy aimed at will be commensurate with the expenditure involved, should, therefore, be kept in view while making a final choice of the method to be adopted.

The main features of a satisfactory overhead rate are as follows : -

- (a) Simple, easy to operate, practical, and accurate.
- (b) Economic in application.
- (c) Fairly stable so that cost from period to period is not vitiated.
- (d) Related to time factor as far as practicable.
- (e) Departmental rates are preferable to blanket rates.
- (f) Area of activity selected for computation of the rate should be a homogeneous cost unit.
- (g) Base for the rate should lay stress on the main production element of the concern. For instance, machine hours will be the appropriate base for machine intensive production.

Under-absorption and Over-absorption of Overhead. The amount of overhead absorbed in costs is the sum total of the overhead costs allotted to individual cost units by application of the overhead rate. It follows that under the actual rate method of absorption, overhead costs are fully charged to production so that the amount absorbed is equal to the amount of overhead incurred, as shown below :

Overhead expenses	Rs. 500	
Direct labour hours	2,000	
Overhead rate	Re. 0.25 per direct labour hour	
Absorption of overhead cost @ Re. 0.25 per direct labour hour :		
<i>Product</i>	<i>Actual direct labour hours</i>	<i>Overhead cost absorbed</i>
		Rs.
A 20	1,000	250
B 45	300	75
C 19	400	100
D 20	100	25
E 21	200	50
	<hr/> 2,000	<hr/> Rs. 500

When a predetermined rate worked out on the basis of anticipated or budgeted overhead is applied to the actual base, the amount absorbed may not be identical with the amount of overhead expenses incurred if either the actual base or the actual expenses or both deviate from the estimates or the budgets. If the amount absorbed is less than the amount incurred, which may be due to actual expenses exceeding the estimate and/or the output or hours worked being less than the estimate, the difference denotes under-absorption. This has the effect of understating the costs as the overhead expenses incurred are not fully recovered in the cost of jobs, processes, etc. On the other hand, if the amount absorbed is more than the expenditure incurred, which may be due to the expenses being less than the estimate and/or the output or hours worked exceeding the estimate, this would indicate over-absorption which goes to inflate the costs. This is shown below :

Budgeted direct labour	Rs. 2,300		
Budgeted overhead	Rs. 1,150		
Budgeted overhead rate	50% of direct labour		
		<i>Period 1</i>	<i>Period 2</i>
		Rs.	Rs.
Actual direct labour			2,400
Overhead absorbed @ 50% of direct labour	1,150	1,150	1,200
Overhead incurred	1,150	1,150	1,100
Under-absorbed overhead	50	50	—
Over-absorbed overhead	—	—	100

Under- or over-absorption of overhead may arise due to one or the other of the *causes* given below :

- (i) Error in estimating overhead expenses.
- (ii) Error in estimating the level of production, i.e. the base.
- (iii) Major unanticipated changes in methods of production.
- (iv) Unforeseen changes in the productive capacity.
- (v) Seasonal fluctuations in the overhead expenses from period to period. The overhead rate is computed by averaging the expenses so that peaks and troughs are eliminated. Though there is under- and over-absorption in the individual periods, these should, over a number of periods in a normal cycle, offset each other.
- (vi) Overhead rate may be applied to the normal capacity which may be less than the full operating capacity of the undertaking. This results in under-absorption of overhead if the overhead rate is calculated with reference to the full capacity ; the amount under-absorbed represents the overhead pertaining to the capacity which remains unutilized.

Situations referred to at (iv), (v) and (vi) above relate to fixed overhead and in the last two cases, the under- or over-absorption is said to be deliberate as the overhead rates are purposely fixed at a certain level in order to (a) smoothen fluctuations from period to period, and to (b) bring out the cost of idle capacity.

An example illustrating the procedure for working out under- or over-absorbed overheads at the end of an accounting period is given overleaf.

EXAMPLE 4 13.

A certain cost centre consists of ten workers using similar machines. The normal week consists of 5 days, totalling 42 hours. Each worker has two weeks' annual holidays, together with other holidays of 5 days per annum. Each week, two hours per operator should be spent in cleaning etc., and it is estimated that illness and absenteeism will cause the loss of 1,000 hours per annum. It is not anticipated that any overtime will be worked, or that any time other than stated will be lost.

Overheads allocated and apportioned to the cost centre, which are to be absorbed at a rate per direct labour hour, total Rs. 13,875, and you are required to calculate the absorption rate.

During the year, actual overheads amounted to Rs. 14,500. Time occupied in cleaning etc. totalled 1,000 hours. Time lost by illness and absenteeism totalled 1,300 hours, time lost by machine breakdown totalled 200 hours. Overtime worked on production during the period amounted to 800 hours.

Present the overhead absorption account at the year-end assuming that standard costing is not in operation. (I C M A, Final Adapted)

ANSWER

Maximum hours (10 × 42 × 52)		21,840
Less Annual holidays hours	$10 \times 42 \times 2 = 840$	
Other holidays hours	$10 \times 42 \times 1 = 420$	1,260
		<hr/>
		20,580

Available hours		
Less Hours in cleaning etc.	$10 \times 2 \times 49 = 980$	
Idleness and absenteeism	1,100	2,080
		<hr/>

Anticipated effective labour hours 18,500

*(Out of 52 weeks only 49 effective weeks are available, the remaining three being lost due to holidays)

Overhead absorption rate, on direct labour = $\frac{\text{Rs. } 13,875}{18,500} = \text{Rs. } 0.75 \text{ per hour}$

Actual :

Maximum hours		21,840
Add Overtime		800
		<hr/>
		22,640

Less . Holidays (840 + 420)	1,260	
Cleaning time	1,000	
Illness and absenteeism	1,300	
Machine breakdown	200	3,760
		<hr/>

Actual effective hours 18,880

OVERHEAD ABSORPTION ACCOUNT

Overhead Control Account (actual overhead incurred)	Rs 14,500	Finished Goods Account (overhead absorbed 18,880 hours @ 0.75)	Rs 14,160
		Costing Profit & Loss Account (overhead under-absorbed)	Rs 340
	<hr/>		<hr/>
	Rs 14,500		Rs 14,500

Accounting of Under- and Over-Absorbed Overhead. The treatment of under- and over-absorbed overheads depends upon the extent of under- or over-absorption and the circumstances leading to it. Three methods of disposing of under- or over-absorbed overheads are discussed here.

(i) *Use of supplementary rates* : If the amount of under- or over-absorption is significant, the cost of the jobs etc. is adjusted by means of a supplementary levy of the overhead. The supplementary rate is determined by dividing the amount of under- or over-absorption by the actual base. Under-absorption is set right by a plus rate while a minus rate is to be determined for adjusting over-absorption. This is illustrated below :

Predetermined overhead rate	Rs. 3 per labour hour
Actual direct labour hours	2,000
Actual overhead incurred	Rs. 5,000
Overhead absorbed	= 2,000 × Rs. 3 = Rs. 6,000
Over-absorption	= Rs. 6,000—Rs. 5,000=Rs. 1,000

Supplementary rate for adjustment of over-absorption = $\frac{\text{Rs. 1,000}}{2,000}$ Re. 0.50 per labour hour

Obviously, this is a minus rate which is applied to the actual hours to reduce the overhead cost already recovered in excess.

The supplementary rate may also be computed as a percentage of the amount absorbed. In the foregoing example, the percentage to be deducted from the amount already absorbed will be :

$$\frac{\text{Amount over-absorbed}}{\text{Amount absorbed}} \times 100 = \frac{\text{Rs. 1,000}}{\text{Rs. 6,000}}$$

Supplementary levy has the ultimate effect of recovering overhead on the basis of actual rates and thus it suffers from the same short-comings as the actual rate method. As practically no use can be made of historical costs, correction of such costs by means of a supplementary rate is unnecessary and merely adds to the clerical expenses. When the overhead rate is linked with capacity other than the actual such as maximum or attainable or normal capacity, a supplementary levy would defeat the purpose for which such a rate was deliberately computed, viz. to reveal idle capacity costs. In the case of seasonal fluctuations in the overhead cost or in the level of activity or production, where the rate is so fixed as to have a uniform recovery throughout the accounting period, supplementary levy is not called for.

Correction of costs through supplementary overhead rates must, however, be made where prices are fixed on costs plus basis. This is also necessary if the management likes to maintain actual historical costs for future comparison purposes.

While the supplementary rate is used to adjust the overhead cost of each cost unit, the under- or over-absorbed amount, total, may at the end of the accounting period, be apportioned on a ratio basis to the three control accounts, viz. Work-in-Progress, Finished Stock, and Factory Cost of Sales Accounts. Apportioning is done prorata to direct labour hours, machine hours, or the values of the balances in each of these accounts, as illustrated below :

Let us assume that there is an over-absorption of Rs. 1,000 and the total actual hours are 2,000, split up as follows :—

Work-in-progress (balance at year end)	400 hours
Finished goods (unsold stock)	600 hours
Factory cost of sales (goods already sold)	1,000 hours
	<hr/>
	2,000 hours

The over-absorption will be adjusted by crediting each of these accounts in the ratio of 4 : 6 : 10.

Works-in-progress Account :	$\left(\frac{4}{20} \times 1,000\right)$	Rs. 200
Finished Goods Account		Rs. 300
Factory Cost of Sales Account		Rs. 500
		<hr/> Rs. 1,000

The adjustment to stock as stated above is made in total at the end of the accounting year and the subsidiary records or individual items are not corrected. The amounts adjusted will be shown in the Balance Sheet as deductions from the work-in-progress and finished goods stocks.

EXAMPLE 4.14.

A manufacturing company absorbs overhead into the cost of its four production departments by means of estimated departmental rates per direct labour hour.

In view of a large difference between the overhead incurred and overhead absorbed for the year, you are asked to investigate. You discover the following information for the year :—

	Departments			
	1	2	3	4
Overhead incurred	Rs. 10,160	Rs. 46,530	Rs. 20,430	Rs. 18,700
Actual direct labour hours worked	25,400	84,600	45,400	37,400
Estimated departmental rates used	Re. 0.5	Re. 0.35	Re. 0.4	Re. 0.6
Total overhead absorbed	Rs. 12,700	Rs. 29,610	Rs. 18,160	Rs. 22,440
Direct labour hours contained in :				
Work-in-progress	3,300	14,480	1,920	6,560
Finished goods	7,480	8,320	4,160	2,920

You are required to :

- Calculate for each department the direct labour hour rates of overhead incurred.
- Calculate the extent to which the values of the (i) end-year work-in-progress and (ii) end-year finished goods should be increased or decreased for each department for the year in view of the corrected overhead rates.

(I. C. M. A., Inter)

ANSWER :

Department	1	2	3	4
Actual overhead	Rs. 10,160	Rs. 46,530	Rs. 20,430	Rs. 18,700
Actual direct labour hours	25,400	84,600	45,400	37,400
Direct labour hour rate (Actual)	Re. 0.40	Re. 0.55	Re. 0.45	Re. 0.50
Absorption rates used	Re. 0.50	Re. 0.35	Re. 0.40	Re. 0.60
Difference to be adjusted	(-) Re. 0.10	Re. 0.20	Re. 0.05	(-) Re. 0.10
Work-in-Progress : Hours	3,300	14,480	1,920	6,560
Adjustment	(-) Rs. 330	Rs. 2,896	Rs. 96	(-) Rs. 656
Finished goods : Hours	7,480	8,320	4,160	2,920
Adjustment	(-) Rs. 748	Rs. 1,664	Rs. 208	(-) Rs. 292

(ii) *Write off to Costing Profit and Loss Account* : When the amount of under- or over-absorbed overheads is not significant enough to justify the use of the rather complicated procedure of supplementary levy, the simple method is to write it off to the Costing Profit and Loss Account. Under-absorption on account of idle facilities should also be written off in this manner irrespective of the amount.

Under this method, the procedure is to make a journal entry at the end of the year transferring the under- or over-absorbed amount to the Overhead Adjustment Account which is ultimately closed to the Profit and Loss Account or the Costing Profit and Loss Account. When overhead rates are determined for periods of less than a year (for example when rates are revised monthly, quarterly, or half yearly), under-absorption or over-absorption is worked out at the end of each such period. The amount, except the one arising due to abnormal causes, e.g. strikes, lockouts, major breakdowns etc., is then carried over to the next period and is taken into account while fixing the rate for that period. It is only the amount remaining under-absorbed or over-absorbed at the year-end which is written off. The method is applicable where the amount of under- or over-absorption to be carried over from one period to another is not considerable ; if otherwise, a supplementary levy is called for to avoid distortion in costs. An example illustrating this method is given below. (It is assumed that rates are predetermined monthly).

Actual position during a month :

Predetermined overhead rate	Rs. 2 per direct labour hour
Actual direct labour hours	2,000
Overhead absorbed	Rs. 4,000
Overhead incurred	Rs. 3,650
Amount over-absorbed	Rs. 350

Budgets for the next month :

Overhead anticipated	Rs. 3,550
Deduct over-absorption (previous period)	Rs. 350
Budgeted overhead	Rs. 3,200
Labour hours	2,000
Predetermined rate	$\frac{\text{Rs. 3,200}}{2,000}$ Rs. 1.60 per direct labour hour

The process is repeated from month to month till the last month of the accounting year. The amount under- or over-absorbed at the end of this month if not carried over to the next year, is written off to the Costing Profit and Loss Account.

Another illustration may seen in Example 4.15.

The main disadvantage of writing off the under- or over-absorbed amounts under this method is that as the portion of under- or over-absorbed overhead which should have been allocated to the stocks of work-in-progress and finished goods is transferred to the Profit and Loss Account or the Costing Profit and Loss Account, the value of such stocks carried over to the next accounting period is either under- or over-stated. However, as the amount of under- or over-absorption is not likely to be very large (as otherwise the supplementary rate method would be applied), no serious distortion in the values of the stock may be anticipated.

(iii) *Absorption in the accounts for subsequent years* : At the year-end, the amount under- or over-absorbed is carried over as a deferred charge or deferred credit to the next accounting year by transfer to a Suspense or Overhead Reserve Account.

This method is open to criticism on the ground that costs should be absorbed in the accounts of the periods in which they are incurred and utilised and thus it is illogical to carry over the overhead cost of one year to be absorbed in the costs of subsequent years. The use of the method may, however, be justified under the following circumstances :—

(a) When the normal business cycle extends over more than one year.

(b) In case of a new project or scheme, the output is low in the initial stages of production and it cannot, therefore, bear the entire overhead, particularly the fixed overhead. If the recovery rate is computed on the basis of normal production over a business cycle, the resulting under-absorbed amount is carried over as deferred revenue expenditure for absorption in the production of future years.

EXAMPLE 4.15.

A Company manufacturing one product uses a rate of overhead per unit.

The following amounts of factory overhead have been budgeted to be incurred for various levels of production :—

Production level (units)	Factory overhead (Rs.)
10,000	14,500
20,000	18,000
30,000	21,000
40,000	23,600
50,000	25,500

The present method of absorption is to compute a rate of overhead for each quarter based on the level of production estimated for the quarter.

It is proposed, however, that this method should be changed to one whereby a rate of overhead is established for the year as a whole, based on a normal production level of 30,000 units per quarter.

For quarters 1 and 2, following data applied :

Quarter	Production level (units)		Factory overhead incurred (Rs.)	Sales (units)
	Estimated	Actual		
1	20,000	19,000	17,500	15,000
2	40,000	42,000	25,000	40,000

There is no work-in-progress at the end of any quarter and no finished stock at the beginning of the first quarter. Finished stock is valued on a first-in first-out basis.

Calculate for each quarter :

1. Under the present method of overhead absorption :

(a) the over- or under-absorbed overhead for each quarter ;

(b) the amount of factory overhead ,

(i) included in overhead costs on the profit and loss account for the quarter ; and

(ii) appearing in the balance sheet at the end of each quarter,

assuming that over- or under-absorption is transferred to the Profit and Loss Account at the end of each quarter ;

(c) the amount of factory overhead :

(i) as in (b) (i) above ; and

(ii) as in (b) (ii) above,

assuming that over- or under-absorption is carried forward until the end of the year.

2. Under the proposed method of overhead absorption ; the items corresponding to the requests made in 1 above at : (a) ; (b) (i) and (b) (ii) ; and (c) (i) and (c) (ii).

(I. C. M. A., Pt. III—Adapted)

ANSWER :

	Present Method		Proposed Method	
	Quarter 1	Quarter 2	Quarter 1	Quarter 2
Overhead rate	$\frac{18,000}{20,000} = \text{Rs. } 0.9$	$\frac{23,600}{40,000} = \text{Rs. } 0.59$	$\frac{21,000}{30,000} = \text{Rs. } 0.7$	$\frac{21,000}{30,000} = \text{Rs. } 0.7$
Absorption on units produced	Rs. 19,000 \times Rs. 0.9 =	Rs. 42,000 \times Rs. 0.59 =	Rs. 19,000 \times Rs. 0.7	Rs. 42,000 \times Rs. 0.7
Actual overhead	17,100	24,780	13,300	29,400
Under-absorbed overhead	17,500	25,000	17,500	25,000
Cumulative under-absorption	400	220	4,200	*4,400
Finished goods (overhead cost only)	400	620	4,200	200
Production	—	4,000 units \times Rs. 0.9	Nil	4,000 units \times Rs. 0.7
Less closing stock	19,000 units 4,000 units (19,000 — 15,000) \times Rs. 0.9	42,000 units 6,000 units \times Rs. 0.59	19,000 units 4,000 units \times Rs. 0.7	42,000 units 6,000 units \times Rs. 0.7
Net value, P & L	13,500	24,840	13,300	28,000
Add under-absorbed	400	220	4,200	(—)4,400
Gross value, P & L	13,900	25,060	17,500	23,600
(a) Under absorption	400	220	4,200	*4,400
(b) (i) Overhead in P & L	13,900	24,840	14,700	23,600
(ii) Overhead in Balance Sheet (i.e. in closing stock)	3,600	3,400	2,800	4,200
(c) (i) Overhead in P & L	13,500	24,840	10,500	28,000
(ii) Overhead in Balance Sheet (i.e. closing stock plus under-absorbed)	4,000	4,160	7,000	**4,000

*Over-absorption

**Over-absorption deducted from closing stock

Procedure for the Accounting of Overhead Costs. The various stages involved in the accounting and control of overhead costs are given in the chart in Fig. 4.11. All indirect costs, as and when incurred, should be entered in the costs records in a specified document or form in which the appropriate Standing Order Numbers to which the costs are to be charged should also be indicated. The different sources of collection and classification of overhead were discussed earlier. The various documents through which overhead costs are accumulated are described in the following paragraphs. It has been assumed that overhead is classified into the primary elements, viz, indirect material, indirect labour, and indirect expenses. The procedure discussed is by no means standard or universal and practices would differ with regard to the nature of the documents and the forms used, and the routine followed for classification and booking of expenditure.

Indirect material : Like direct material, indirect material is issued to cost centres on materials requisitions. The requisition indicates the cost centre drawing the material and the Standing Order Number to which the material cost is to be charged. These details are used for classification as well as departmentalisation of the cost.

The use of requisitions journal and materials issue analysis sheets (see Figs. 2.20 and 2.24) in accounting of the issue of materials was described in Chapter 2. Indirect material costs, booked in details against the various Standing Order Numbers are posted in the requisitions journal or in the materials issue analysis sheet ; these are periodically totalled up and the totals posted in the respective Overhead Control Accounts, i.e. the Factory, Administration, or Selling and Distribution Overhead Control Accounts, as the case may be.

Indirect labour : The labour time records constitute the basic documents for the purpose of booking indirect labour costs to departments and to the Standing Order Numbers. The method of analysis of time records by making use of wages analysis book (see Fig. 3.21) was discussed in Chapter 3. The wages pertaining to indirect workers are extended to columns for the various Overhead Control Accounts and the totals of these columns are posted to the Factory, Administration, or Selling and Distribution Overhead Control Accounts, as the case may be.

Indirect expenses : The primary documents in which indirect expenses are recorded were indicated in Page 200.

Payments made for purchases of miscellaneous stores and for services rendered by outside parties are recorded in invoices or vouchers. The vouchers are posted in the overhead column of the purchase journal or the voucher register. At the end of the accounting period, the overhead column of the voucher register is totalled and the amount debited to the respective Overhead Control Accounts.

Pay and allowances paid to officers and staff other than workers are collected from the relevant pay or salary bills. The details of the payments are posted in the payrolls ; the total of the payrolls is debited to the Overhead Control Accounts. Another method is to debit payment of salaries together with the amount of wages paid to the workers to the Wages Control Account.

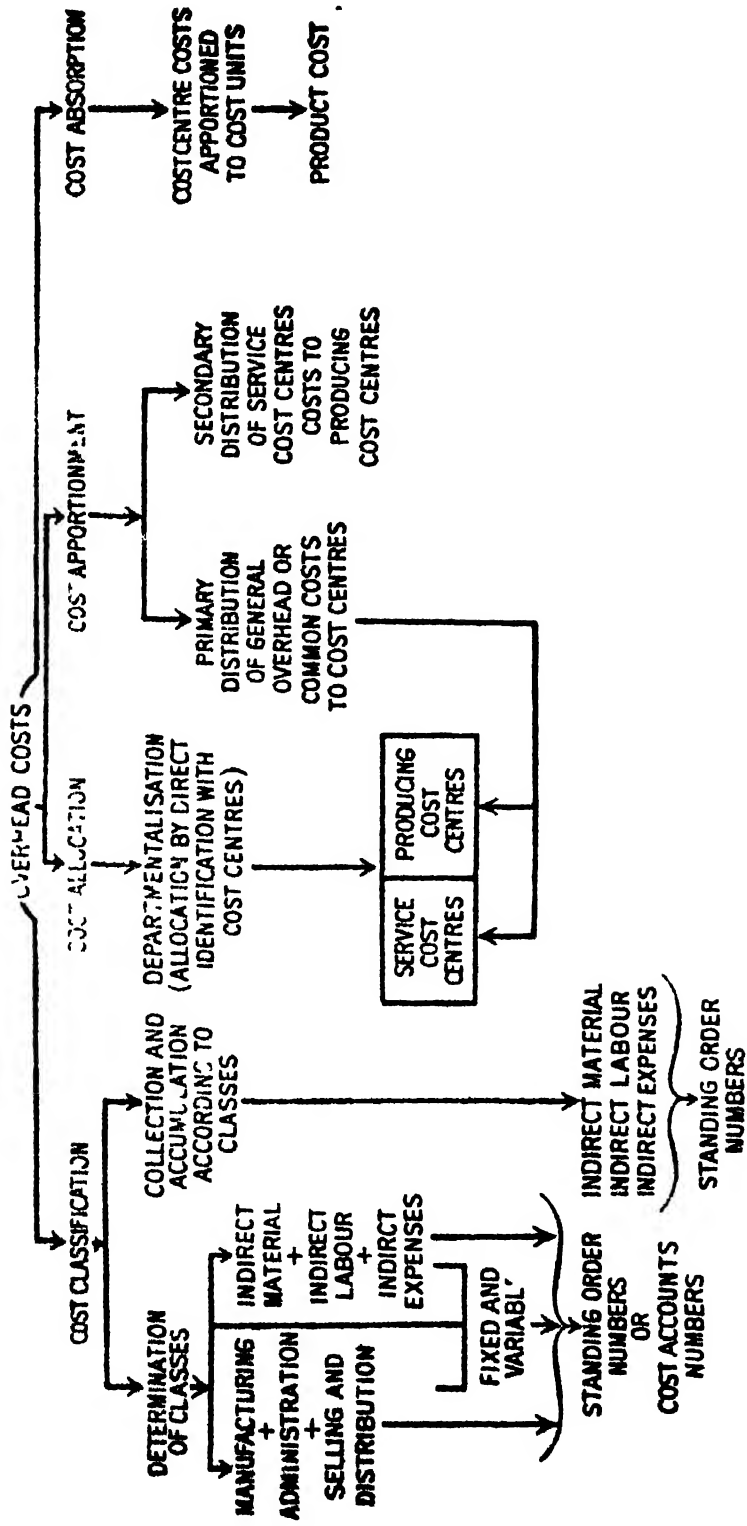


Fig 411 Accounting of Overhead Costs

There are other items of expenses which, unlike the above mentioned payments, do not involve any cash outlay. Such items are : outstanding liabilities, i.e. expenses not paid but accrued such as insurance, rates, rent, and taxes, or items like depreciation needing adjustment in cost accounts only, no cash payment being necessary. These are posted in relevant subsidiary statements or records and periodically totalled up ; the totals are posted in the respective Overhead Control Accounts.

Expenses pre-paid are deducted from the actual expenses incurred so that the correct amount relating to the period is taken into account.

Corresponding to the materials issue analysis and wages analysis sheets, a *Summary Expenses Statement or Expense Allocation Statement* is prepared which summarises all the vouchers pertaining to the indirect expenses according to each Standing Order Number. The total of the summary expenses statement is reconciled with the total posted to the various Overhead Control Accounts.

Primary Distribution : Primary distribution of the actual overhead, accumulated and classified according to Standing Order Numbers, is done at the

PRIMARY DISTRIBUTION SHEET				
Period . .	Standing Order No.			
	Particulars			
	Current period	Previous period	Budgeted for current period	Variar (Actual from budget) Rs.
	Rs.	Rs.	Rs.	
Service departments or cost centres				
No. 1				
2				
3				
4				
Producing departments or cost centres				
A				
B				
C				
Total				

Fig. 4.12. Primary Standing Order or Primary Distribution Sheet

end of the accounting period in a suitable form. A form for this purpose, which may be termed *Primary Standing Order or Primary Distribution Sheet*, is given in Fig. 4.12. One form is made out for each Standing Order Number in which all allocations and apportionments to the various service and producing cost centres are shown. Budgeted costs are also presented in the form so that comparison may be made with the actuals and variances determined.

Secondary distribution : Secondary distribution is done in another form termed *Secondary Standing Order or Secondary Distribution Sheet* (see Fig. 4.13) which is maintained for each service and producing department cost centre.

SECONDARY DISTRIBUTION SHEET					
Period :	Service		Department :		
	Producing				
Standing Order No.	Current period costs Rs.	Previous period costs Rs.	Budgeted costs for current period Rs.	Variance (Actual from budgeted) Rs.	
Apportioned from : Department No. 1 2 3 4					
Total					

Fig. 4.13. Secondary Standing Order or Secondary Distribution Sheet

It records the cost allocated to the department against each Standing Order Number as well as the amount apportioned from the other service departments. Thus, each sheet is a complete record of the overhead cost for a department or a cost centre.

Absorption : Overhead absorbed at predetermined rates against jobs or production orders is recorded in an *Overhead Absorption or Applied Overhead Analysis Sheet*. The analysis is made in respect of each department. A form of the analysis sheet that would be suitable where machine hour rate is in use is given in Fig. 4.14. The analysis sheet is summarised weekly or monthly and the totals are posted to the various control accounts. (Control accounts have been discussed in detail in Chapter 6.) The total overhead absorbed in a period for a producing department as per the analysis sheet is compared with the total overhead incurred (i.e. the expenses for the department and the share apportioned from service departments), as shown in the secondary distribution sheet ; the difference should represent the amount of overhead under-or over-absorbed in the department.

OVERHEAD ABSORPTION ANALYSIS		
Department/Cost Centre :	No. :	
Machine hour rate :	Period :	
Production Order or Job No.	Machine Hours	Overhead absorbed Rs.
Total		

Fig. 4.14. Overhead Absorption (or Applied Overhead) Analysis Sheet

Capacity Costs. Capacity costs are the costs that are incurred for providing production, administrative and selling and distribution facilities to enable a company to carry out its operations. They include costs of plant and equipment (for providing production capabilities), warehouses, delivery vehicles etc. (for selling and distribution facilities) and key personnel (for administrative facilities). Capacity costs also include depreciation of buildings and equipments, taxes and insurance of property and salaries of the key personnel. It will be apparent that, occurring as a result of long-term planning, capacity costs are in the nature of long run costs and they last for extended periods of time. Capacity costs are also committed costs in the sense that once the decision is made and funds are spent on building up the facilities, the costs cannot be easily changed.

Capacity Levels. We had seen that in the calculation of overhead rates, certain activity levels like direct labour hours, machine hours, direct labour cost, and physical units of products are adopted as the base. Determination of the actual overhead rate on any of these bases presents no difficulty as the actual level of capacity achieved would be taken for the purpose, but when predetermined rates are computed, a decision is required to be taken as to what would be the most suitable level to be adopted. The overhead rate will vary according as one or the other of the various types of capacities (discussed in the following paragraphs), such as normal, expected, or maximum capacity is adopted as the basis. For example, if maximum capacity is assumed to be 10,000 labour hours and the expected capacity as 80%, i.e. 8,000 labour hours, the overhead rates for an estimated expenditure of Rs. 10,000, based on the two levels, will be :

Rate based on maximum capacity : $\frac{\text{Rs. } 10,000}{10,000}$ = Rs. 1 per labour hour

Rate based on expected capacity : $\frac{\text{Rs. } 10,000}{8,000}$ = Rs. 1.25 per labour hour

The following types of plant capacity levels may be considered :

1. *Maximum or Theoretical Capacity* : This is the cent per cent rated capacity of a plant installed, i.e. the maximum possible productive capability of a plant or department as rated (i.e. specified by the manufacturers or the erectors of the plant) that may be achieved provided no operating time is lost. Under practical conditions in a plant or shop, this capacity can seldom be reached. Maximum capacity is, therefore, for all purposes only a theoretical capacity.

2. *Practical Capacity* : Also known as *Operating Capacity*, practical capacity is actually the maximum productive capacity of a plant after the predictable and unavoidable factors of interruption such as time lost for breakdowns, repairs, set-ups, normal delays, Sundays and holidays, inventory-taking periods, etc., have been taken into account. Thus, practical capacity is the maximum capacity minus the inevitable interruptions. The capacity for a department in a specified period of time is related to the resources provided and number of shifts, days and hours worked. Practical capacity does not consider external factors causing reduction in production, e.g. lack of orders from customers, or unbalanced capacity in certain departments.

The nature and extent of interruptions would depend upon the type of the plant, nature of the product, and other circumstances as stated above. It may, however, be assumed that on an average, interruptions account for 10% to 15% of total capacity so that practical capacity may safely be taken as 85% to 90% of maximum capacity.

3. *Capacity based on sales expectancy* : A firm may not be able to sell the entire production it is capable of achieving with the result that the capacity worked is less than the operating capacity. Capacity based on expected sales is determined after a careful study of the market for the products has been made.

4. *Actual Capacity* : Actual capacity is the volume of production achieved in a specified period. This is a short-term concept and the actual capacity may move between the practical capacity level and the capacity based on sales expectancy, or even below it.

5. *Normal Capacity* : Opinions differ as to what should be regarded as the normal capacity of a plant. One opinion is to take normal capacity as the long-term average of the sales expectancy level. The period selected for computing the average may be two or three years according to the period of the normal business cycle and seasonal variations. As production is related to sales, the actual capacity worked would swing round the normal capacity based on expected sales so that the average of actual capacity achieved during a selected period would be equal to the normal capacity based on sales expectancy. The latter is, therefore, also known as *Average capacity*.

Another view is to take normal capacity as the capacity that would be worked if there were no lack of orders. In other words, normal capacity may be equal to the practical operating capacity.

Another opinion, which does not find much favour is to take maximum capacity as the normal capacity.

The *importance* and *objectives* of establishment of normal capacity are :

- (i) Fixation of budgets ; determination of normal plant capacity constitutes the foundation for the budgetary system.
- (ii) Computation of overhead rates.
- (iii) Establishment of selling prices.
- (iv) Setting up of standards and basis of calculating standard costs of products.
- (v) Control of costs.
- (vi) Reduction of costs.
- (vii) Basis for scheduling production and fixation of operating schedule.
- (viii) Valuation of inventory.
- (ix) Measurement of effect of changes in volume of production.
- (x) Determination of break-even point.

In the determination of normal capacity, the rated capacity of a plant and the sales potential are not as important as its physical capacity and average sales expectancy. The latter should be determined on a long-term basis in order to level out cyclic fluctuations. While determining normal capacity, machinery and equipment purchased for use in future, and obsolete and outmoded machinery should be excluded.

6. Idle Capacity : The difference between practical capacity and the capacity based on sales expectancy represents idle capacity. The cost of idle capacity is clearly brought out if the overhead rate is based on practical capacity. (This is discussed in the following section.) If, however, the actual capacity is less even than the capacity related to average sales expectancy, idle capacity is represented by the difference between the practical and actual capacities.

The distinction between *idle capacity* and *excess* or *surplus capacity* should be noted. Idle capacity refers to temporary idleness because of lower or less production due to lack of orders or due to other causes. The idea is that as soon as the difficulties in achieving production are removed, idle capacity is wiped out and the full capacity is restored. Excess capacity, however, relates to long term concept and it arises due to retention of larger production capacity than what can be expected to be used, or due to unbalanced machines and equipments within the departments. While the overhead rate may or may not include cost of idle capacity, the expenditure on excess capacity should always be excluded in computing overhead rates. Excess capacity costs are not treated as product costs but are considered to be expenses chargeable to Profit and Loss Account.

Sometimes, the capacities of the various departments in a factory are not properly balanced or matched. For example, if a product passes through two departments A and B in sequence, and if the capacity of A is 200 units per day for one operation and that of B is 150 units per day for the other operation, the latter department causes a bottleneck. Excess capacity arising due to such imbalances because of bottlenecks in certain departments, may be reduced or eliminated by taking action as indicated in the next page.

Bottleneck department

- (i) Working overtime.
- (ii) Working additional shift.
- (iii) Temporary off-loading, i.e. transferring operations from the department to other departments where spare capacity is available.
- (iv) Purchase of additional equipment.

Other departments

Sub-contracting the excess work.

If it is not possible to balance the capacity, or if excess capacity arises due to other causes, it would be a prudent policy to dispose of the machinery and equipment that cause the excess capacity.

In the computation of departmental overhead rates, situations of imbalances create problems. Overhead rate may be set by taking as normal, the capacity of either the department causing the bottleneck or the other departments whose capacities remain unutilized. If the normal capacity of a department is set without reference to those for the bottleneck departments (e.g. at 200 units per day in the above example), the excess capacity cost will be reflected in the amount of overhead cost under-absorbed in the department and the cost of its products will not be saddled with the excess cost. This assists in the control of costs by easily segregating the cost of unbalanced capacity. If, however, the normal capacity is set with reference to the bottleneck department (i.e. at 150 units), the excess cost is charged to the cost of products. This method may, therefore, be more suitable where the price of products is mainly based on costs, e.g. in cost plus contracts.

Overhead based on Normal Capacity. Under the concept of normal costs, pre-determined overhead costs are charged to cost units at normal capacity.

$$\text{Normal overhead rate} = \frac{\text{Normal overhead}}{\text{Base at normal capacity}}$$

Depending upon the particular activity level selected to represent normal capacity, the overhead rate is worked out in the following manner :

Capacity level	Maximum (100%)	Practical (90%)	Average on expected sales (80%)
Direct labour hours	10,000	9,000	8,000
Budgeted :			
Fixed overhead	Rs. 6,000	Rs. 6,000	Rs. 6,000
Variable overhead	Rs. 5,000	Rs. 4,500	Rs. 4,000

Case 1. Normal capacity related to practical capacity

$$\text{Overhead rate : Fixed} = \frac{\text{Rs. 6,000}}{9,000} = \text{Rs. 0.66 per labour hour}$$

$$\text{Variable} = \frac{\text{Rs. 4,500}}{9,000} = \text{Rs. 0.50 per labour hour}$$

$$\text{Total overhead rate} = \text{Rs. 1.16 per labour hour}$$

Case 2. Normal capacity related to sales expectancy

Overhead rate : Fixed	= $\frac{\text{Rs. 6,000}}{8,000}$	Rs. 0.75 per labour hour
Variable	= $\frac{\text{Rs. 4,000}}{8,000}$	Rs. 0.50 per labour hour
Total overhead rate		Rs. 1.25 per labour hour

Case 3 Normal capacity related to maximum capacity

Overhead rate : Fixed	= $\frac{\text{Rs. 6,000}}{10,000}$	Rs. 0.60 per labour hour
Variable	= $\frac{\text{Rs. 5,000}}{10,000}$	Rs. 0.50 per labour hour
Total overhead rate		Rs. 1.10 per labour hour

It will be seen that while the variable overhead rate is constant in all the three cases, it is the fixed overhead rate that varies according to the level adopted as the normal capacity. This happens because the capacity cost which represents the cost of providing and maintaining the total operating capacity is mainly fixed in nature, the amount of which does not change with the level of capacity. If the actual capacity utilized in a period be assumed to be 7,000 direct labour hours, the effect of calculating overhead rates on the basis of each of the three capacities will be as follows :—

	<i>Fixed overhead rate per labour hour</i>	<i>Overhead applied on actual labour hours (i.e. 7,000 hours)</i>	<i>Under-absorbed fixed overhead (i.e. Rs. 6,000 minus overhead applied)</i>
Case 1	Rs. 0.66	Rs. 4,620	Rs. 1,380
Case 2	Rs. 0.75	Rs. 5,250	Rs. 750
Case 3	Rs. 0.60	Rs. 4,200	Rs. 1,800

The under-absorption in Case 1 represents the cost of idle capacity or capacity unutilized due to lack of sales orders provided that no amount of under-absorbed cost is attributable to other causes such as change in level of spending or difference between the predetermined and actual overhead rates. The under-absorption reflects a sort of loss to be shown against the sales department for its inability to sell, or against the production department if the idle capacity is a result of retaining excess or surplus capacity. Similarly, the under-absorption in Case 2 represents the cost of idle capacity due to expected sales not having materialised. Had the actual capacity been more than the capacity based on sales expectancy, this would have resulted in over-absorption. Under-absorption in Case 3 represents the cost of idle capacity inclusive of the unavoidable interruptions.

Some accountants are of the view that current production should bear the cost of idle capacity, i.e. the costs of both used and idle capacity should be absorbed in product costs. Another school of opinion treats idle capacity costs as expenses chargeable to profit and loss account but not forming any part of cost of production.

Determination of overhead rates using practical capacity as the base has the following *advantages* :—

- (i) Production is charged with the amount of variable overhead which is budgeted for the activity level and with the fixed overhead of only the capacity utilised.
- (ii) Cost of idle capacity is indicated in the form of unabsorbed fixed cost. This assists in the control of volume variances.
- (iii) Variations in volume can be reasonably explained.
- (iv) Practical capacity of a plant provides a stable base as it can be assessed with a fair degree of accuracy. The overhead rates determined with reference to this base are, therefore, relatively more accurate.
- (v) Costs are not affected by variations in sales volume, stocks are correctly valued, and profits are accurately calculated.

On the other hand, the method of calculation of overhead rates on the basis of capacity at sales expectancy has certain *advantages*. These are :

- (i) The amount of fixed overhead charged to the cost of production bears the same ratio to the total fixed overhead as the actual activity bears to the capacity based on expected sales.
- (ii) Overhead costs are recovered in production in full.
- (iii) The cost per unit worked out is useful as a basis for making decisions on price fixation and for integration in the budgetary plan.

EXAMINATION QUESTIONS

1. Discuss overhead as a factor in the determination of management policy of a concern manufacturing variety of products which are not subject to any price control.
(I. C. W. A., Final)
2. Distinguish between
 - (a) Cost classification and cost allocation.
 - (b) Cost apportionment and overhead absorption.
 (I. C. W. A., Inter)
3. "Costs are not inherently fixed but acquire this characteristic as a result of policies established by management". Is this view correct ?
(I. C. W. A., Final)
4. How would you separate fixed and variable costs ? What are the primary and additional uses to which such information can be put to ?
(I. C. W. A., Final)
5. What do you understand by departmentalisation of overhead ? Why is this done ? How would you departmentalise the following expenses ?
 - (a) Consumable stores
 - (b) Power
 - (c) Repairs and maintenance
 - (d) Depreciation
 - (e) Material handling expenses.
 (I. C. W. A., Inter)
6. In a single output manufacturing unit having four stages of production, it is contended that there is no necessity of finding the impact of overheads in each stage. What are your views for and against this contention for any unit you are familiar with ?
(I. C. W. A., Inter)

7. Discuss briefly the two main purposes of departmentalisation. Prepare an operating statement for any service department with which you are familiar comparing actual and budgeted expenses. Mention the industry and the nature of the service department. *(I. C. W. A., Inter)*
8. A manufacturing company has four producing sections and four service departments. Illustrate in a tabular form with proforma figures the collection and apportionment of a few of the major items of indirect expenses enumerating the basis of apportionment and final absorption in the output. *(I. C. W. A., Inter)*
9. Briefly describe two ways of dealing with the problem of apportioning service department costs amongst service departments which, in addition to doing work for the main operational departments, also serve one another. *(I. C. M. A., Part IV)*
10. As a Cost Accountant explain with reasons how you would treat the following items in cost accounting?
 - (a) Depreciation of a new boiler replacing the old one burst during operation.
 - (b) Initial heavy expenditure on advertising introducing a new brand of consumer article.
 - (c) Financing charges for the acquisition of both fixed assets and inventories.
 - (d) Abnormal losses due to various causes during processing.
 - (e) Extra provision for rehabilitation and replacement of old equipment.
 - (f) Infrequent heavy expenditure on relining of furnaces. *(I. C. W. A., Inter)*
11. How would you treat the following expenses in Cost Accounts?
 - (a) Expenses incurred in moving and rearranging plant and machinery.
 - (b) Cost of foundry pattern.
 - (c) Bonus paid to employees for an annual festival.
 - (d) Packing cases required for export.
 - (e) Labour welfare expenses. *(I. C. W. A., Final)*
12. An industrial installation requires large quantities of coal as raw material as well as various other materials which are not bulky in nature. Discuss how you would deal with the following in the cost accounts keeping in view the general rule that accuracy in cost classification should be achieved at reasonable cost only.
 - (a) Incurring transportation charges on materials purchased.
 - (b) Material handling charges. *(I. C. W. A., Inter)*
13. What basis would you recommend for the departmental apportionment of any six of the following items of expenses giving justification for the suggested one?
 - (i) Internal transport
 - (ii) Process steam
 - (iii) Colony maintenance
 - (iv) Air conditioning
 - (v) Labour office
 - (vi) General factory maintenance
 - (vii) Depreciation
 - (viii) Motive power *(I. C. W. A., Inter)*
14. How would you treat the following items in Cost Accounts?
 - (a) Store keeping losses of materials.
 - (b) Spoiled work.
 - (c) Canteen subsidy.
 - (d) Idle facilities. *(I. C. W. A., Inter)*
15. How are the following items treated in cost accounts?
 - (a) Carriage outwards.
 - (b) Salaries of officers and supervisory staff.
 - (c) Employees' contribution to Provident Fund of direct workers as well as indirect workers.
 - (d) Fire insurance premiums.
 - (e) Expenses of welfare department. *(I. C. W. A., Inter)*

16. (a) List out a few items that may be included under material overheads. How are they recovered in costs?
(b) Explain how the following items are treated in cost accounts :
(i) Overtime premium.
(ii) Scrap. (I. C. W. A., Inter)
17. How would you deal with the following problems in a rapidly expanding business?
(a) Treatment of increased overheads.
(b) Control of expenses incurred in the installation of new machines. (I. C. W. A., Inter)
18. In the Glass Bottle industry, a tank of molten glass with automatic machines attached is the production centre. These tanks have to be closed down for four months every two years while expenditure on repairs and rebuilding takes place. Discuss the costing problems involved. (I. C. M. A., Inter)
19. A factory, having its own power-generating plant, increases its electric power supply by taking current from the "grid" at a different price. What statistics would you keep, and how would you compute the cost of electric power in connection with departmental apportionment? (I. C. W. A., Inter)
20. A factory has three departments served by overhead electrically operated travelling cranes, each of which in its complete operating distance traverses the three departments and conveys products, heavy and light, from department to department.
(a) State the possible bases on which the operating expenses of the cranes could be apportioned to the departments.
(b) What information would be required to arrive at the _____ each department? (I. C. W. A., Inter)
21. A factory which mainly executes job orders has two departments.
(a) Department 'A' has 50 workers and machines worth Rs. 5 lakhs whereas there are 500 workers in department 'B' which has machinery worth Rs. 50,000.
What use would you make of these data in selecting the overhead rate?
(b) A factory executes Government contract on cost-plus basis and also manufactures for sale in the market. There are separate departments for each activity. Overhead is applied at normal rates calculated on the basis of sales demand and capacity to meet the demand.
Variations are noticed in each month between the amount of overhead applied and that actually incurred. How do you propose to adjust the under- or over-applied overhead? (I. C. W. A., Final)
22. What is a cost centre? Show a compilation of overhead absorption rate for a cost centre predominantly mechanised. Use figures from any industry with which you are familiar. (I. C. W. A., Inter)
23. The method of disposal of overhead in accounts is not as important as their trends under varying conditions of production particularly in fluctuating market. Discuss. (I. C. W. A., Final)
24. List five documents that you would expect to find in connection with the collection, allocation and apportionment of indirect expenses including labour and material. In respect of each document listed, mention briefly the function that it performs. (I. C. M. A., Inter)
25. In a factory there are two related departments A and B whose production capacities are unbalanced. Examine the possible methods for computing the normal capacity of each department for calculation of absorption rates of overhead, given following conditions :—
(a) Department B has no other source of material except from department A.
(b) Condition (a) remaining, the product of A commands a market. (I. C. W. A., Final)
26. How would you apportion the following expenses between departments A and B?
Rent and rates £360, Employer's liability insurance £230, Store expenses £742, General factory labour £284, Fire insurance £260, Depreciation £900, National Insurance £527, Holiday pay £520, Plant repairs £450.

Information regarding the departments is as follows :

	Deptt. A	Deptt. B
Floor Space	60ft × 115ft	45ft × 100ft
Number of employees	18	42
Annual direct wages	£5000	£6000
Annual direct labour hours	36000	92500
Plant value	£10000	£2500

(I. C. M. A., Inter)

27. Explain briefly any one method by which the expenses of the Service Departments are apportioned to the Production Departments, in cases where the Service departments render service to each other also. A company has three Production Departments A, B and C and two Service Departments X and Y. The expenses incurred by them during a month are :

A — Rs 80,000	X — Rs 23,400
B — Rs. 70,000	Y — Rs 30,000
C — Rs 50,000	

The expenses of the Service Departments are apportioned to the Production Departments on the following basis :

	A	B	C	X	Y
Expenses of X	20%	40%	30%	—	10%
Expenses of Y	40%	20%	20%	20%	—

Show clearly how the expenses of X and Y Departments would be apportioned to A, B and C Departments.
(I. C. W. A., Inter)

28. A manufacturing company has two departments X and Y and all products pass through both departments. The following figures relate to production cost for June, 1962

	Deptt X	Deptt Y
Direct labour hours	6,000	4,000
Machine hours	4,500	2,000
Raw materials	Rs. 1,00,000	Rs. 50,000
Direct wages	Rs 6,000	Rs 8,000
Overheads	Rs 45,000	Rs 10,000

Job card for Job No. 1 shows :

Raw materials	Rs 3,000	Rs 1,000
Direct wages	Rs 250	Rs 380
Direct labour hours	225	200
Machine hours	200	600

What method would you recommend for absorbing overhead? Give reasons. Compute the cost of Job No. 1 under the method recommended by you and under one another method of overhead absorption.
(I. C. W. A., Inter)

29. A machine shop contains four newly purchased machines, each occupying practically equal amount of space, and costing respectively—A£400, B£600, C£600 and D£800. The following are the expenses per annum of the machine shop :—

	£
Rent	200
Rates and water	83
Light and heat	63
Power A	102
Power B	100
Power C	240
Power D	290
Administration	190
Running expenses, works, sundries, labour, repairs etc.	400

Prepare a Machine Hour Rate for each machine, assuming a 44 hours week, 50 weeks per year and 80% utilization. (I. C. M. A., Final)

30. A manufacturing company absorbs overhead into the cost of its four productive departments by means of estimated departmental rates per direct labour hour. In view of a large difference between overhead incurred and overhead absorbed for the year, you are asked to investigate. You discover the following information for the year :—

Deptt.	Overhead incurred £	Actual direct labour hours worked	Estimated departmental rate used £	Total overhead absorbed £	Direct labour hours contained in :	
					Work-in-progress	Finished goods
1	10,160	25,400	.5	12,700	3,300	7,480
2	46,530	84,600	35	29,610	14,480	8,320
3	20,430	45,400	4	18,160	6,920	4,160
4	18,700	37,400	6	22,420	6,560	2,920

You are required to :

- (a) Calculate for each department the direct labour hour rates of overhead incurred ,
 (b) Calculate the extent to which the value of the (i) year-end work-in-progress and (ii) year-end finished goods should be increased or decreased for each department for the year in view of the corrected overhead rates. (I. C. M. A., Inter)
31. In a factory department there are three machines with the following expenses have been allocated :—A Rs. 619, B Rs. 607, C Rs. 951. In addition, there is an overhead crane to bring material to the machines as necessary. The expenses allocated to this crane are Rs. 570.

During the period of this expenditure, the machines were used as follows :—

	Machines		
	A (Hours)	B (Hours)	C (Hours)
With use of crane	160	130	480
Without use of crane	428	577	—
	588	707	480

Calculate a machine rate for each machine distinguishing between the hours in which the crane is used and those in which it is not. (I. C. W. A., Inter)

32. Specify and define briefly two methods of establishing cost rates based on labour. Using the following information, calculate the rates for each method for each department. State the conditions under which each method is suitable.

Departments			
Budgeted wage cost	Rs. 10,000	Rs. 4,800	Rs. 3,150
Budgeted output (units)	6,360	32,000	35,000
Standard times (per unit)	4 hours	15 mins.	12 mins.
Budgeted cost levels	Rs. 8,480	Rs. 6,000	Rs. 4,200

(I. C. M. A., Pt. II—Adapted)

33. In order to meet increased orders a manufacturing company proposes for the whole of the next year to undertake half shift working from 6 P.M. to 10 P.M. for five days a week by additional labour. The company's labour force works a forty-hour week for fifty weeks per year and at present comprises 300 direct workers in shop X and 200 direct workers in shop Y at an average wage rate of 7s. 6d. per hour.

The additional workers will need to be paid one-third above the normal average wage rate for the shop. There will be 50 additional direct workers in shop X and 25 additional direct workers in shop Y. The budgeted overhead for the year excluding any shift work, and the expected changes in that overhead resulting from shift work, are as follows :—

	<i>Before Shift work</i>		<i>After Shift work</i>	
	<i>Shop X</i>	<i>Shop Y</i>	<i>Shop X</i>	<i>Shop Y</i>
	£	£		
Indirect wages	30,000	20,000	Plus 20%	Plus 15%
Worker's weekly salaries	9,000	14,000	„ £3,175	„ £3,250
Worker's monthly salaries	21,000	12,500	„ £1,000	„ £1,000
Repairs to plant	7,500	1,500	„ 20%	„ 10%
General expenses	3,000	1,500	„ 15%	„ 15%
Light and heat	2,400	1,800		
Indirect materials	1,800	600	Proportionate to increased direct labour hours	
Consumable stores	6,000	1,800		
Power materials	4,800	1,800		
Other overhead items (not affected by shift work)	34,500	16,500		
	<u>£ 1,20,000</u>	<u>£ 72,000</u>		

Your are asked to :

- Calculate the budgeted direct labour hour rates of overhead for shop X and shop Y if no shift work is undertaken
- Prepare a budgeted statement of the overhead costs for shop X and shop Y if shift working is undertaken as planned.
- Calculate the budgeted direct labour hour rates of overhead for shop X and shop Y resulting from the statement prepared in answer to (b) above.

(I. C. M. A., Pt. II)

34. In a factory producing motor cycle parts, the production of 'fuel tank' passes mainly through press shop, welding shop, hand fabrication shop and painting shop. In the first shop, each half of a tank is drawn out of steel sheets by means of 'dies' through a heavy and costly press, two-halves of a tank are welded together in the welding shop, dents, etc., are removed and other operations done in the hand fabrication shop and finally the complete tank is painted in the paint shop.

On taking over the appointment of Cost Accountant, you find that for cost estimation purposes one overhead rate, viz. 200 per cent on direct wages is applied for the factory as a whole.

A budget of expenses for the year 1968 shows the following :—

	Rs.
Direct wages	1,26,000
Factory overhead	2,52,000
Indirect material including welding and painting materials	35,000
Depreciation	29,000
Power	7,000

An analysis of direct wages etc., is as follows :—

	<i>Direct wages</i>	<i>Indirect material</i>	<i>Depreciation</i>	<i>Power</i>	<i>No. of workmen</i>
	Rs.	Rs.	Rs.	Rs.	
Press shop	25,200	—	25,000	6,000	20
Welding	37,800	15,000	1,000	—	30
Hand fabrication	37,800	—	—	—	30
Painting	25,200	20,000	3,000	1,000	20

The effective labour hours are estimated to be 2,00,000 during 1968.

Do you consider the present system of estimation by adopting one rate of overhead for the factory as a whole would meet the requirements? If not, after assuming other data, if considered necessary, calculate the rates of overhead for different sections keeping in view the nature of work in each. What method of recovery of overheads do you prefer in each case and why? (I. C. W. A., Final)

35. A machine is purchased for cash at Rs. 9,200. Its working life is estimated to be 18,000 hours after which its scrap value is estimated at Rs. 200. It is assumed from past experience that :—

- (i) the machine will work for 1800 hours annually ;
- (ii) the repair charges will be Rs. 1080 during the whole period of life of the machine,
- (iii) the power consumption will be 5 units per hour at 6 p. per unit.

Other annual standing charges are estimated to be :—

(a) Rent of department (machine 1/5th)	Rs. 780
(b) Light (12 points in the department—2 point, engaged in the machine)	Rs. 288
(c) Foreman's salary (1/4th of his time is consumed in the machine)	Rs. 6,000
(d) Insurance premium (fire) for machinery	Rs. 36
(e) Cotton wastes	Rs. 60

Find out the Machine Hour Rate on the basis of the above data for allocation of the works expenses to all jobs for which the machine is used. (M. Com., C. U.)

36. The New Enterprises Ltd. has three Production Departments A, B, C, and two Service Departments D, and E. The following figures are extracted from the records of the company :—

	Rs.
Rent and rates	5,000
General lighting	600
Indirect wages	1,500
Power	1,500
Depreciation of Machinery	10,000
Sundries	10,000

The following further details are available :—

	Total	A	B	C	D	E
Floor space (sq. ft.)	10,000	2,000	2,500	3,000	2,000	500
Light points	60	10	15	20	10	5
Direct Wages (Rs.)	10,000	3,000	2,000	3,000	1,500	500
H. P. of Machines	150	60	30	50	10	—
Value of Machinery (Rs.)	2,50,000	60,000	80,000	1,00,000	5,000	5,000
Working hours	—	6,226	4,028	4,066	—	—

The expenses of D and E are allocated as follows :—

	A	B	C	D	E
D	20%	30%	40%	—	10%
E	40%	20%	30%	10%	—

What is the total cost of an article if its raw material cost is Rs. 50, labour cost Rs. 30 and it passes through Departments A, B, and C for 4, 5, and 3 hours respectively? (I. C. W. A., Inter)

37. A factory is currently working to 50 per cent capacity and produces 10,000 units. Estimate the profits of the company when it works to 60 per cent and 80 per cent capacity and offer your critical comments.

At 60 per cent working, raw material cost increases by 2 per cent and selling price, by 2 per cent. At 80 per cent, raw material cost increases by 5 per cent and selling price falls by 5 per cent.

At 50 per cent capacity working, the product costs Rs. 180 per unit and is sold at Rs. 200 per unit. The unit cost of Rs. 180 is made up as follows :—

Material	100
Labour	30
Factory Overhead	30 (40% fixed)
Administration overhead	20 (50% fixed)

(I. C. W. A., Inter)

38. Superfines Ltd. has furnished the following particulars for the half year ended March 31, 1978. Compute the departmental overhead rates for each of the production departments, assuming that the overheads are recovered as a percentage of direct wages.

		Production Departments			Service Departments	
		A	B	C	X	Y
Direct Wages	Rs.	4,000	6,000	8,000	2,000	4,000
Direct Material	Rs	2,000	4,000	4,000	3,000	3,000
Number of Employees	No.	100	150	150	50	50
Electricity	KWH	8,000	6,000	4,000	2,000	2,000
Light Points	No	10	16	4	6	4
Asset Value	Rs.	1,20,000	80,000	60,000	20,000	20,000
Area Occupied, Sq. Metres		150	250	100	50	50

The overhead expenses for the above period were :

Motive Power	Rs 3,300
Lighting	400
Stores Expenses	800
Staff Welfare Expenses	4,800
Depreciation	30,000
Repairs	15,000
Rent, Rates & Taxes	12,000
General Expenses	12,000

Apportion the expenses of service department 'X' in proportion to the direct wages and that of service department 'Y' in the ratio of 5 : 3 : 2 to production departments 'A', 'B' & 'C'.

(I. C. W. A., Inter)

39. The cost of an article at a capacity level of 5,000 units is given under A below. For a variation of 25% in capacity above or below this level, the individual expenses vary as indicated under B below :

	A (Rs.)	B
Material cost	25,000	100% varying
Labour cost	15,000	100% varying
Power	1,250	80% varying
Repairs and maintenance	2,000	75% varying
Stores	1,000	20% varying
Inspection	500	20% varying
Depreciation	10,000	100% varying
Administration overhead	3,000	25% varying
Selling overhead	5,000	50% varying
Total	Rs. 62,750	
Cost per unit	Rs. 12.55	

Find the unit cost of the product under each individual expenses at production levels of 4,000 units and 6,000 units.

(I. C. W. A., Inter)

CHAPTER 5

NON-MANUFACTURING COSTS

By tradition, cost accountants have been concentrating their attention mainly on manufacturing costs. The increased importance given these days to non-manufacturing costs such as administration, marketing, and research and development costs because of their increasing size as a percentage to total costs, emphasizes the need to focus attention on these costs. The techniques used for control of manufacturing costs and decision making on the basis of manufacturing costs are, by and large, also applied to non-manufacturing costs. However, cost benefit analysis in the area of non-manufacturing costs presents some difficulty because the benefits are not as easily measureable as in the case of manufacturing costs.

In this chapter, we deal with the analysis and control of different types of non-manufacturing costs including administrative costs, marketing (selling and distribution) costs and research and development costs

ADMINISTRATION OVERHEAD (OR ADMINISTRATIVE COSTS)

The administration division of a concern is, by and large, responsible for planning and control of the organisation. It lays down policies to be followed and ensures through proper direction that these policies are effectively carried out. The function of administration is quite distinct from the other major functions of a manufacturing concern, namely the production, selling and distribution functions. Administration overheads constitute the overhead expenses pertaining to the administrative division. Administration overheads, termed administrative costs by some accountants, are mainly in the nature of indirect costs and refer to all expenditures incurred in formulating the policy, directing the organisation and controlling the operation of an undertaking which is not directly related to research, development, production, distribution or selling activity functions. Examples of administration costs are as follows :—

<i>Administration overhead</i>	<i>Selling overhead</i>	<i>Distribution overhead</i>
Accounts office expenses	• Advertisement	Carriage out and transport
Audit fees	• Bad debts	Insurance on finished stock
Bank charges	• Brokerage	Packing and shipping
Depreciation of office buildings and equipments	• Market research	Transport vans
Directors' remuneration	• Salaries and commission of salesmen, selling agents etc.	Warehouse expenses
Factory Estate	• Sales office expenses	Wastage of finished goods
General administration expenses		
Legal expenses		
Office salaries, supplies, and other expenses		
Postage		
Repairs and maintenance of office buildings and equipments		
Secretary and his staff		
Stationery		
Telegrams and telephone		

The undermentioned special features of administration overhead distinguish it from the other classes of overhead costs :

- (a) In most cases, the amount of administration overhead would be small compared to the other classes of overhead expenses, viz. the manufacturing, selling, and distribution overheads.
- (b) The nature of administration overhead is such that for most of the items of expenses, it is not possible to fix suitable norms or standards against which the actual expenses could be compared. These overhead costs are, therefore, not susceptible to the same degree of control that is possible in the case of manufacturing overhead.
- (c) The methods of absorption of administration overhead in product costs are mostly arbitrary as a result of which cost ascertainment cannot be said to be very accurate or equitable.

Depending on the organisational structure, there are usually two types of administration costs incurred in a large manufacturing concern, viz.,

- (i) Administration costs incurred within the plant or factory itself. This would be to provide staff and other administrative support to the factory. The costs involved are controllable at the factory level.
- (ii) Administration costs incurred centrally in the Head Office (which may be situated outside the factory in a different station or location). If the company has more than one plant, a share of the administration costs is allocated to each plant on a suitable basis. Obviously, such costs will be planned and controlled at the headquarters and not at the factory level.

Accounting of Administration Overhead. The relatively small size of expenditure relating to administration and the difficulties encountered in its accounting and control have given rise to a school of opinion that advocates treatment of administration overhead as period costs, to be excluded from product costs. The opinion is further supported by the argument that administration overhead has no direct relationship either with output or with the quantum of sales.

Regardless of the fact whether it is ignored by writing off to Costing Profit and Loss Account or is applied to cost units, the procedures for the primary accounting and analysis of administration overhead, i.e. its classification, allocation and departmentalization follow the same pattern as has already been described for manufacturing overhead. Administration overhead is classified according to the nature and purpose of expenditure, each type of expenditure being represented by a separate Standing Order Number (or Control Account Number) allotted for the purpose. The set of Standing Order Numbers for administration overhead should be separate and distinct from the series of numbers maintained for manufacturing, selling, or distribution overhead. A control account, viz. Administration Overhead Control Account is opened in the cost books to record the total administration overhead expenses incurred in an accounting period. The relevant journal entries are shown in Chapter 6.

Similar to the procedure adopted for manufacturing overhead, the next step in the accounting and control of administration overhead is to departmentalise the expenses. The subdivision of the administrative set-up of an undertaking into departments depends upon several factors and each concern has its own classification of such departments. A typical list of administration departments which serve as cost centres for the purpose of collection and control of administration overhead is given below :

Accounts Department
Factory Estate Department
General Office

Legal Department
Personnel Department
Secretarial Department

The expenses that can be identified with specific departments are allocated direct. The rest of the expenditure is apportioned to the various departments on suitable bases in a manner similar to that for manufacturing overhead.

Three methods for the accounting of administration overhead are discussed below. While the first method advocates the exclusion of administration overhead from costs, the other two provide for the absorption of administration overhead in costs.

(i) *Transfer to Costing Profit and Loss Account* : This method is simple ; at the end of the accounting period, the Administration Overhead Account is closed by transfer to Costing Profit and Loss Account.

The arguments advanced in favour of the method of excluding administration overhead from costs are stated above. The main *criticism* brought out against this procedure are as follows :—

- (a) Administration overhead forms an equally important portion of the costs as the other classes of overhead do and it should not, therefore, be ignored.
- (b) Inadequacy of control should not be made a ground for completely eliminating administration expenses from costs.
- (c) Exclusion of administration overhead understates the costs of jobs, processes, etc.

(ii) *Apportionment to manufacturing, selling and distribution functions* : The procedure adopted is to suitably apportion the administration overhead between the production, and the selling and distribution divisions of the concern. The ultimate effect is that administration overhead loses its identity and is merged with manufacturing, selling and distribution overheads. The *principles* underlying this method are as follows :—

- (a) Every manufacturing concern has only two basic functions to perform, namely to produce and market, and all other functions including administration are auxiliary or incidental to these basic functions. Administration overhead should, therefore, have no separate entity and all such expenses should be borne by only these two basic divisions.
- (b) Manufacturing, selling and distribution costs are easier to control than administration overhead. Merges of the latter with the other classes of overhead, therefore, facilitates control.
- (c) Manufacturing, selling and distribution costs can be completely and correctly ascertained only when administration costs are included therein.

As the nature of the various items of administration overhead expenses are different from one another, each item is taken up and analysed separately for the purpose of apportionment. In regard to some of the items, it is possible to make direct allocation according to the amount spent for each division. In most cases, however, the problem is not as simple, and equitable bases have to be adopted for apportioning each type of expenditure. The bases adopted for apportionment of manufacturing overhead will also be found useful here. Some illustrations are given below :

<i>Expenses</i>	<i>Basis of apportionment</i>
Correspondence	Number of letters drafted
Depreciation of office building	Floor area or capital value
Filing	Number of items handled
Invoicing	Number of invoices
Legal expenses	Number of employees
Office rent and rates	Floor area
Personnel Department expenses	Number of employees
Typing	Number of letters typed

The expenses apportioned to manufacturing overhead are treated in the same way as other items of manufacturing overhead. Each item is first allocated or apportioned to service cost and producing cost centres ; the cost of service cost centres are then apportioned to the producing cost centres and ultimately absorbed in cost units. The method of treatment of administration overhead apportioned to selling and distribution is the same as that for selling and distribution overhead (dealt with in another section of this chapter). In the control accounts, the total amount of the administration overhead incurred is debited to the Administration Overhead Control Account. On apportionment, the amounts pertaining to production are debited to the Manufacturing or Factory Overhead Control Account or Work-in-Progress Account and those pertaining to selling and distribution are debited to the Selling and Distribution Overhead Control Account.

The main criticisms against this method of dealing with administration overhead flow out of the following points :-

- (a) Apportionment to the two functional divisions presents considerable difficulty ; the methods adopted for the purpose are mostly arbitrary and the results are unreliable.
- (b) Administration is an equally important function of an undertaking. Merger of administration overhead with the other functions does not reveal the correct relationship between these functions.
- (c) One of the arguments advanced for the method is the difficulty involved in controlling administration costs. This difficulty cannot easily be overcome by the merger of administration overhead with the other classes of overhead expenses.

A modification of the above method may be mentioned here. Administration overhead may be merged completely in the manufacturing overhead or with the selling and distribution overhead instead of being apportioned between the two. Merger with one function or the other is dependent upon the relative importance of the two functions and is practicable only when one of the functions is insignificant compared to the other.

(iii) *Addition as a separate item of cost* : In this method, administration overhead is added as a separate element to the cost units sold and is shown as such in the cost sheets. Stocks of finished goods and work-in-progress are not charged with administration overhead. A suitable base is selected for adding administration overhead to the cost of goods sold and a rate is determined much in the same way as is done for the determination of overhead rates, discussed in the previous chapter. The various bases are :

- | | |
|-----------------------------------|----------------------|
| (a) Sales value or sales quantity | (d) Conversion cost |
| (b) Selling cost | (e) Production units |
| (c) Works cost | (f) Gross profit |

The method is illustrated below (it is assumed that conversion cost is the basis adopted for allocation) :

Budgeted administration overhead		Rs 2,000
Budgeted conversion cost of sales		Rs 10,000
Administration overhead rate	$\frac{\text{Rs. 2,000}}{\text{Rs. 10,000}}$	= 20% on conversion cost
<i>Cost of Product X</i>		
Direct materials		Rs 200
Conversion cost		
Direct labour	Rs. 200	
Factory overhead	Rs. 200	
	<hr/>	
Administration overhead		Rs 400
(20% on conversion cost)		Rs. 80
		<hr/>
		Rs 680

When administration overhead constitutes a small proportion of the total costs, absorption as a separate item is not considered quite suitable. Then, among the alternative bases mentioned above, conversion cost basis seems to be more sound. Because administration costs are incurred in formulating policy, directing the organisation, and controlling the operations, it is but logical to absorb them in proportion to the costs incurred on these functions. This is also more equitable than the works cost basis because the cost of materials consumed in a product has no relationship with administration overhead.

The first two bases mentioned at (a) and (b) above lay stress on the sales function while the third, (c) refers to the manufacturing function. The particular base selected for a concern would largely depend upon its suitability and equity under the given circumstances.

Control of Administration Overhead. Being in the nature of expenditure on the general and financial administration of an undertaking, a major portion of the administration overhead constitutes policy costs that are of a fixed type and are largely non-controllable. The difficulties encountered in the fixation of standards for measuring the effectiveness of administration expenses render the control all the more problematic. For these reasons, it is not considered worthwhile to incur further expenditure in introducing and operating a system of control for administration costs. The argument, however, may not hold much

ground if we consider the fact that in the absence of some sort of a control, the size of administration costs may tend to grow disproportionately.

In spite of the difficulties involved, the normal methods of controlling costs may, with suitable adjustments, be applied to administration costs as well. These methods are explained below :

- (i) *Suitable classification and comparison with past performance* : Administration overhead, classified against Standing Order Numbers and against the various administration departments or cost centres is compared periodically with the corresponding expenditure incurred during a specified past period. This, however, provides only a limited degree of control and the comparison becomes practically noneffective if the level of activity is not constant during the periods under consideration. Some control may be exercised if the records of activity of a department during the various periods are available. The overhead absorption rates may also be compared from period to period : the extent of under- or over-absorption will reveal the efficiency or otherwise of a department. It may sometimes be possible to compare the cost of a department with the cost of similar services obtained from outside. As for instance, the cost of the Legal Department may be compared with the cost of having a part time legal adviser. If the latter is more economic, the Legal Department may even be abolished.
- (ii) *Budgetary Control* : A system of budgetary control of administration overhead can be introduced in a manner similar to that for manufacturing overhead. This has been discussed in another chapter. It may, however, be mentioned here that budgets are set for each item of administration overhead for each administration department so that periodical comparisons with the actuals can be made and responsibility can be fixed on the departments.
- (iii) *Standard Costing* : Control of administration overhead through a system of standard costing is discussed in Chapter 12.

Administration overhead expenses may be classified into two parts, viz.

(a) the expenses that vary with the quantum of work in office, and (b) the expenses that are of a fixed nature. It is possible to fix appropriate units of measurement for each of the variable items which would assist in setting standards or budgets. Fixed administration costs, such as depreciation of office buildings, office machines and equipments are uncontrollable at lower levels of management and may, therefore, be included in a separate fixed cost budget for the information of the top management.

The special problems connected with some items of administration overhead and their treatment in cost accounts are discussed below.

Accounts and Cost Department Expenses. In small concerns, the Accounts and Cost departments expenses are included in the overall administration overhead. In large undertakings, the expenditure may require further analysis say, by grouping under a number of standing orders and under different cost centres

For example, the expenses of the sections dealing with the accounting of materials may be treated in a manner similar to store keeping expenses, the cost of wages section may be apportioned to the various cost centres on the basis of number of employees or time spent for each, and so on.

Cost of Estimates Preparation and Tendering. If the expenditure on estimating and tendering is not very heavy, it may be included under administration overhead. Treatment of the expenditure, if significant, may be as follows :—

- (i) If the items for which estimates are prepared are of a standard nature, the expenses may be treated as selling overhead.
- (ii) When manufacture is undertaken according to the customer's specifications, the expenditure may be charged to manufacturing overhead.
- (iii) When no benefit is derived from the expenditure, it is treated as infructuous and excluded from costs.
- (iv) When benefit is likely to be obtained in future periods and the amount involved is comparatively heavy, this may be treated as a deferred charge.

Interest on Capital. Interest is paid on borrowed capital such as loans and debentures. Whether or not to include interest on capital in cost accounts has been a point of debate. Much of the controversy ranges round the point whether interest, not actually paid, which may be termed notional (or imputed) cost, should be computed and accounted for in costs. Notional cost is a hypothetical cost taken into account in a particular situation to represent a benefit enjoyed by an entity in respect of which no actual expense is incurred. For example, some concerns may charge interest on capital employed as a notional cost.

For the accounting of interest, the following three alternative methods are adopted :—

- (i) Include interest paid but exclude interest not paid, from cost accounts.
- (ii) Include in costs, interest paid and unpaid.
- (iii) Exclude from costs, interest paid or unpaid.

While the last method has little to commend itself and may be limited only to the exclusion of interest paid from the manufacturing costs, difference of opinion is mainly in respect of the first two methods. The particular method adopted by an undertaking would depend largely upon the circumstances of the case and the policy of the management.

The arguments put forth for and against the inclusion of interest in costs are summarised below :

For inclusion :

- (i) According to the economist's concept, interest is a reward of capital as wages are the reward of labour. Like wages, interest should be included in costs.
- (ii) The effect of the varying extent and mode of capital facilities utilized by different products, operations, and processes can be clearly brought

out by including interest. One operation may require expensive machinery whereas another may be performed by hand only, or certain raw materials or products such as timber or wine may require more capital outlay during the time they are allowed to season or mature, or heavy investment may be made on stock piled inventory. In all such cases, comparison of costs and assessment of true profit can be made only by including interest.

- (iii) For cost comparison for the purpose of evaluating alternative proposals such as, whether to buy or manufacture a part or component, or whether to purchase an equipment or obtain it on hire, interest should be included in costs. (As a counter argument it may, however, be said that proposal evaluation may as well be made by keeping statistical data, without including interest in costs.)
- (iv) The time taken for say, construction contracts is different for each contract. The effect of the time element in such cases can be brought out correctly by including interest in costs.
- (v) The effect of retaining large inventory may be accurately assessed by including interest.

Against inclusion.

- (i) According to the accountant's concept, capital is rewarded by profits. There is thus, no case for charging interest to costs.
- (ii) Cost accounts should take care of actual expenditure only.
- (iii) Being an item of pure finance, interest should be met out of profits.
- (iv) Difficulty in determining the computed rate of interest and the capital employed introduces an element of approximation in costs that requires adjustments from time to time. This creates unnecessary complications and also results in increased clerical costs.
- (v) Interest inflates the values of work-in-progress and finished stock and if not paid, it distorts true profits by inclusion of unrealised income.

The distortion of the profit may, however, be obviated by charging interest to cost of sales only. At the end of the accounting period, the amounts of interest proportionate to cost of sales, work-in-progress, and finished stock are computed and the interest pertaining to the cost of sales is credited to the Profit and Loss Account. The procedure is illustrated below :

	<i>Amount</i>	<i>Proportion</i>	<i>Allocation of interest</i>	<i>Amount after allocation of interest</i>
Cost of sales	Rs. 2,00,000	20/25	Rs. 1,600	Rs. 2,01,600
Finished stock	Rs. 40,000	4/25	Rs. 320	Rs. 40,320
Work-in-progress	Rs. 10,000	1/25	Rs. 80	Rs. 10,080
	<u>Rs. 2,50,000</u>		<u>Rs. 2,000</u>	<u>Rs. 2,52,000</u>

Journal entries :

Dr. Overhead Control Account	Rs. 2,000	
Cr. Interest Reserve Account		Rs. 2,000
Dr. Interest Reserve Account	Rs. 1,600	
Cr. Profit and Loss Account		Rs. 1,600

Balance sheet entries :

Finished stock	Rs. 40,320	
Less unrealised interest	Rs. 320	
		Rs. 40,000
Work-in-progress	Rs. 10,080	
Less unrealised interest	Rs. 80	
		Rs. 10,000

Mechanised Tabulation Expenses. A mechanised tabulating department prepares several types of tabulations to serve the needs of the various sectors of the undertaking. The tabulating expenses are apportioned to the manufacturing, administration, selling, and distribution divisions in accordance with the nature and extent of service which the department renders to each of the divisions. Expenses relating to computer may also be treated in a similar manner. Suitable bases for apportioning tabulation expenses are :

- (i) Number of cards punched, sorted, and tabulated.
- (ii) Tabulating machine hours or computer hours (if a computer is in use).
- (iii) Direct allocation to departments, wherever it is possible to identify the expenses to particular departments.

Planning and Production Control Departments. The functions of the Planning and Production Control departments include planning of jobs, operations, and product manufacture, laying down production schedules for the various shops, determination, co-ordination, and regulation of the work load in the departments, and determination of the quality and quantity of materials required to be ordered and kept in stock. As the Planning and Production departments render service to the producing and other service cost centres, the expenses may be apportioned to these cost centres on the basis of direct labour hours or the number of workers in each cost centre.

Rent for Owned Premises. While there is no doubt about the inclusion of rent paid for hired or leased buildings being included in costs, the point whether notional rent, i.e. rent not paid for premises owned should be included is open to controversy. Most of the arguments advanced for and against the inclusion of interest in costs are applicable in the case of rent also. The consensus, however, is for inclusion, in support of which the following further points are pressed forward :—

- (i) Assessment of rent is easier than the computation of fair rates of interest and the determination of capital employed.
- (ii) Inclusion of rent makes the owned premises comparable with property taken on rental basis. This facilitates correct cost comparison.
- (iii) Inter-firm comparison of costs of production of companies having owned factories with similar costs of companies having leasehold or rented factories is facilitated.

- (iv) Rent is more akin to depreciation ; like depreciation, rent should also be charged to cost.

Sundry Administration Expenses. Such miscellaneous expenses may include :

- | | |
|---|---------------------------------------|
| (i) Audit fees | (v) Postage, telephone, and telegrams |
| (ii) Directors' fees | (vi) Printing and stationery |
| (iii) Executives' salary, allowance, bonuses
travelling expenses, etc. | (vii) Rates and taxes |
| (iv) Legal expenses | (viii) Subscriptions and donations |

These expenses are classified separately in the financial books but are merged together in the cost accounts as general administration overhead and absorbed in costs by any of the methods previously discussed. For the purpose of control, however, booking to separate Standing Order Numbers or maintaining suitable statistics with comparative figures of past actuals and budgeted expenditure may be helpful. Frequent computation of comparative percentages on the total costs may be useful in controlling these expenses.

Taxes. Taxes paid by an undertaking are of several types. Taxes or rates paid to local bodies like municipalities or corporations are mostly levied on property owned by the concern. Such taxes are treated as overhead costs and are apportioned to manufacturing, selling, and distribution overhead according to the use of the property made by each of these functions. Sales tax and octroi, excise, and customs duties are paid on goods purchased; these form part of stores overhead expenses. Sales tax realised from customers is actually money received on behalf of the government. It passes through a suspense account which is cleared as soon as payment is made to the government and thus, sales tax is not included in costs. But if sales tax is merged in the sale price and is not collected separately from the customer, the payment is treated as selling overhead. Central taxes like income tax levied on the corporate sector are appropriations from profits and as such they are not included in costs. Taxes on vehicles constitute transport service maintenance costs. Other taxes connected with the factory, e.g. factory registration, licence, etc. are charged to manufacturing overhead.

SELLING AND DISTRIBUTION OVERHEAD

Selling and Distribution (Marketing) Functions. The main function of a manufacturing concern is to produce and sell. Similarly, the function of a non-manufacturing concern, like a wholesale or retail business is to purchase and sell goods or merchandise. In both cases, we find that selling (and incidentally, distribution also) is a common function and thus, selling and distribution costs are incurred by all concerns, both manufacturing and non-manufacturing. As most of the items of selling and distribution expenses are not identifiable with products, these are in the nature of indirect costs.

The sole aim of an undertaking is to maximise profits. This can be achieved by increasing production and at the same time, by increasing turnover by making efforts to push sales in the existing market or through entry in new markets. Increase in production, no doubt, reduces costs but this is not enough unless sales can also be increased to meet the increased volume of output. With

increased efforts for promoting sales and also due to increase in competition, considerable expenditure is incurred on selling and distribution and this sometimes exceeds even the cost of manufacture. After-sales service for special products like radios, televisions, refrigerators, washing machines, and sewing machines, and special facilities given to wholesalers, retailers, and direct consumers further tend to increase selling and distribution costs. Accounting and control of these *after-production costs*, as selling and distribution expenses are often called, have, therefore, assumed increased importance.

The necessity for proper accounting of selling and distribution costs arises from the following :—

- (i) Determination of the cost of sales of jobs and products and the extent of the profitability of each. Costs are not complete and profits cannot be worked out correctly unless selling and distribution costs are included.
- (ii) Control of selling and distribution costs.
- (iii) Price fixation and formulation of sales price policy.
- (iv) Fixation of optimum sales level.
- (v) Decision-making in regard to sales, e.g. selling under differing conditions, in different markets and regions, by different methods.

The term *Marketing Costs* and its two main sub-classifications, viz. *Promotional Costs* and *Physical Distribution Costs* are now being increasingly used to represent the costs covered under selling and distribution overhead. Promotional costs, also known as *order getting costs* refer to those costs that are incurred to stimulate orders for the products, such as advertising, sales promotion, remuneration of sales staff etc. Promotional costs are mainly discretionary and the objective of such costs is to generate sales. Physical distribution costs are also known as *order filling costs* and are incurred mainly for the purpose of moving the products. Order processing costs, warehousing, and transport etc. that are meant for the physical distribution of the products are classified under physical distribution costs. In this text, however, we have retained the use of the term selling and distribution overhead that would encompass marketing costs and their sub-classifications.

Selling Costs. All expenses incurred for the purpose of selling to the existing customers or for increasing sales to the existing and potential customers are grouped together under the head, 'selling cost' or 'selling overhead'. Selling overhead may be further sub-divided as follows . -

- (i) **Direct selling costs :** The costs incurred on sales executives, sales staff, and sales office may be grouped under this head. Their functions include : (a) soliciting and obtaining orders, (b) market investigation to ascertain size, nature, and extent of the market, and (c) issuing goods to customers. Some examples of direct selling costs are given below :

Remuneration (salaries, commission, bonus, travelling expenses etc.) of salesmen, sales agents, and other executives connected with sales.
Office expenses, e.g. telephone, postage, stationery, rates and rent.

Expenses on sales show room, sales depot, etc.

Remuneration of installation staff.

After-sales service costs in respect of items of products which are installed in the customers' premises and maintained, either free under guarantee for a specified period after sales or on payment.

Expenses incurred in furnishing tenders and quotations for sales.

- (ii) *Advertisement and sales promotion* : The main item of expenditure under this heading is *advertisement*. Other examples are :

Sales promotion, like partaking in exhibitions, displays, posters, cinema films, etc

Distribution of samples, free gifts, diaries, calendars, etc

Expenses on pamphlets, circulars, etc meant to educate customers

Market analysis with a view to changing the demand position

- (iii) *Credit and collection* : Under this head may be included bad debts and expenses on debt collection, e g.,

Expenses of debt collecting office

Legal costs for debts realisation, etc

- (iv) *Financial and general administration* : Examples of selling costs included under this head are

Royalty on sales

Discounted allowances.

Administration costs prorated to selling function

Sales invoicing

Accounts

Distribution Costs. During the time lag between the completion of manufacture of a product and placing it in the hands of the customer, certain expenses like storage and transportation costs are incurred. These overhead expenses are known as distribution costs. Distribution costs may be grouped under the following heads :—

- (i) *Transportation* : This includes expenditure on different modes of transport and comprises *salaries of vehicle running and maintenance staff, depreciation and insurance of vehicles, etc* Other examples are :

Demurrage, wharfage, tools, etc

Insurance to cover sold goods while they are in transit

Expenditure on return of goods and their despatch

- (ii) *Warehousing and storage costs* : The following expenses may be grouped under this head :—

Secondary packing for storage.

Cost of storage of finished products such as warehouse rent, salaries of warehouse staff, warehouse office expenses, internal transport, and depreciation.

Loss of finished stock in warehouse, insurance of finished stock.

- (iii) *Financial and general administration* : Distribution expenses grouped under this head are :

Cost of carrying stock investment.

Buying of supplies for Distribution department.

Administration overhead apportioned to distribution.

Financial accounts and cost accounting of distribution.

It will be seen from the above that the functions of selling and distribution are separate and the expenses under the two heads can be easily segregated. There is, however, overlapping of the two functions in some undertakings where selling and distribution overhead costs are merged together. The common accounting practice in the U.S.A. is to group together all after-production costs under one head, termed as distribution costs. The main reason for this is that from the cost ascertainment point of view, maintenance of selling and distribution overhead as separate entities does not serve any useful purpose. Unless expenses are high in specific cases where separate treatment in detail is necessary, selling and distribution overhead costs are dealt with together.

Accounting of Selling and Distribution Overhead. The procedure for the accounting of selling and distribution overhead usually comprises a *three-stage analysis* discussed below :

- (i) According to nature or object of expenditure.
- (ii) By functions or cost centres (or locations).
- (iii) By products or cost units.

(i) *Analysis by nature and object of expenditure* : Selling and distribution expenses are analysed into a number of basic or primary types in accordance with their nature and object. Each type of expense is allotted a Standing Order or Cost Account Number. Items of expenses, as and when incurred, are booked to the Standing Order Number to which they belong. This classification is similar to the classification and collection of manufacturing overhead.

It is difficult to lay down an exhaustive list of types under which selling and distribution overhead may be classified. The classification given below is by way of illustration :

Advertising	Fees	Packing
Commission	Freight	Postage
Customs duty	Heating	Power
Depreciation	Insurance	Rebates
Discounts	Lighting	Rent
Excise	Materials and consumable stores	Repairs

Just as different items of manufacturing overhead costs behave differently with the volume of output, some items of selling and distribution overhead vary with the volume of sales or production, while others are fixed. Selling and distribution expenses may accordingly be divided into three categories, viz. fixed, variable, and semi-variable. For example, with regard to the volume of sales, salary of sales executive in the head office is fixed, travelling allowance and salary of field salesmen are semi-variable, and commission paid to salesman is variable.

(ii) *Functional analysis* : This is similar to the departmentalisation and apportionment of manufacturing overhead to cost centres. The following are the main operational functions by which selling and distribution overhead may be further classified. Each of these functions (which are like departments or cost

Standing Order No or Account No.	Particulars	Basis of apportionment	Total	Direct selling	Advertising and sales promotion	Transport	Warehousing and storage	Credit and collection	Financial	General administration	Miscellaneous
			(Figures have been omitted)								
	Total	Rs	70,000	40,000	10,000	8,000	5,000	2,000	3,000	1,500	500

Fig. 5.1. Analysis of Selling and Distribution overhead by nature of expenses and functions

centres), is in charge of an executive head so that with the help of functional analysis, responsibility can be fixed on the executives.

- | | |
|------------------------------------|---------------------------|
| 1. Direct selling | 5. Credit and collection |
| 2. Advertising and sales promotion | 6. Financial |
| 3. Transportation | 7. General administration |
| 4. Warehousing and storage | 8. Miscellaneous |

Selling and distribution expenses analysed according to the types under the various Standing Order Numbers, as described in the preceding paragraphs, are further allocated to one or the other of the above functions to which they pertain. Items of general overhead which cannot be allocated to any particular function are apportioned, i.e. distributed prorata to these functions on suitable basis. When no suitable basis is available, intuited proportions are applied. The method of analysis is shown in the statement in Fig. 5.1.

The above analysis is also extended to locations, i.e. to the various territories, sales offices, etc. and to customers, salesmen, etc. Thus, each item of selling and distribution cost is first analysed by functions and then by locations. The procedure is similar to the primary and secondary distributions of manufacturing overhead; each function or location constitutes a cost centre for the accounting and control of selling and distribution overhead. The secondary analysis by locations is illustrated in Fig. 5.2.

Function	Basis of allocation	Total	Territory I East Zone	Territory II South Zone	Territory III West Zone	Territory IV North Zone
		Rs.	Rs.	Rs.	Rs.	Rs.
Direct selling	Direct	40,000	5,000	15,000	8,000	12,000
Advertisement and sales promotion	Sales value	10,000	5,000	1,000	1,500	2,500
Transportation	Distance	8,000	2,000	3,000	1,000	2,000
Warehousing & storage	Sales volume	5,000	500	3,000	500	1,000
Credit & collection	No. of orders or percentage of cash collected	2,000	200	1,400	200	200
Financial	Sales value or value of stock	3,000	250	1,350	400	1,000
General administration	No. of orders, invoices, or sales voucher	1,500	100	500	100	800
Miscellaneous	Direct	500	50	250	50	150
Total		Rs. 70,000	13,100	25,500	11,750	19,650

Fig. 5.2. Analysis of Selling and Distribution Overhead by Locations

The bases commonly used for apportionment of selling and distribution overhead to functions or locations are given below :

<i>Selling and Distribution Overhead</i>	<i>Base</i>
Advertisement	Sales value or physical unit
Warehousing	Sales volume
Rent	Floor space
Insurance	Value of property
Depreciation	Capital value of assets
Transport	Weight or number of packages, or distance carried
Credit control	Number of orders

Certain expenses like remuneration of salesmen etc , freight charges, packing materials, etc may be allocated direct. A detailed discussion of these expenses has been made elsewhere in this chapter.

As already stated, the analysis of selling and distribution overhead according to locations etc assists in fixing responsibility. The analysis also facilitates ascertainment of the margin of profit earned by each location, as illustrated below :

ZONAL PROFIT STATEMENT

Zone	West	Period	January, 19
Sales			Rs. 10,000
Factory cost of sales	Rs. 24,000		
Selling and distribution overhead (as per analysis statement)	Rs. 11,750		
Cost of sales			Rs. 35,750
		Net Profit	Rs. 4 250

(iii) *Analysis by products or group of products* : Selling and distribution is next analysed by products or group of products (see Fig 5 3). The analysis is similar to the absorption of manufacturing overhead in cost units. However, there are two points of dissimilarity between the methods of analysis of selling and distribution overhead by products and the absorption of manufacturing overhead in products. While no item of manufacturing overhead is directly identified with cost units (if otherwise, such item would no longer be an item of overhead), some items of selling and many items of distribution overhead like packing, transport, etc , may be allocated to products. Direct allocation is a simple affair where separate selling departments exist for specific products. Further, while manufacturing overhead is absorbed in the cost of manufacture, selling and distribution overhead, like administration overhead, is apportioned to the cost of goods sold.

Analysis of selling and distribution overhead may also be made by product groups. For this purpose, the products may be grouped in accordance with their common factors like price, method of sales, salesmen, and sales orders. For

Function	Basis of Allocation	Territory I East Zone		Territory II South Zone		Territory III West Zone		Territory IV North Zone	
		Rs.	Product A	Rs.	Product B	Rs.	Product A	Rs.	Product B
Direct selling		40,000	3,000	2,000	15,000	—	8,000	3,000	9,000
Advertisement & sales promotion		10,000	2,500	2,500	1,000	—	1,500	1,250	1,250
Transportation		8,000	200	1,800	3,000	—	1,000	1,600	400
Warehousing & storage		5,000	250	250	3,000	—	500	500	500
Credit & collection		2,000	120	80	1,400	—	200	80	120
Financial		3,000	125	125	1,500	—	400	500	500
General administration		1,500	40	60	500	—	100	200	600
Miscellaneous		500	50	—	250	—	50	100	50
Total		Rs. 70,000	6,285	6,815	25,500	—	11,750	7,230	12,420

Fig. 5.3. Analysis of Selling and Distribution Costs by Products

(As shown in Fig. 5.2 or apportioned by the methods described on Page 304)

example, analysis may be made according to the goods sold at wholesale price and goods sold at retail price.

It will be observed that analysis of selling and distribution overhead by products is simply an extension of the functional analysis. It measures the effectiveness of the selling and distribution costs with regard to their application to the various products. Such an analysis is said to be an *analysis by manner of application*. There are two other methods of analysis by manner of application, viz. (a) by channels of distribution and methods of sales, and (b) by customers. The various channels of distribution for this purpose are : (i) direct to customer, (ii) through retailers, and (iii) through a chain of wholesalers and retailers. Customers may be classified according to the size or frequency of purchases made by them, or according to the nature of their operation.

Functional costs which cannot be directly allocated to cost units are apportioned by the following methods :—

- (a) *A rate per article* : The base selected may be the number or some other physical unit of product. Advertisement, transportation, and warehousing expenses may be apportioned by this method.
- (b) *A percentage of turnover* : This is suitable for apportionment of direct selling costs, general administration and finance cost, and miscellaneous expenses.
- (c) *A percentage of cash collected* : This may be used for apportionment of bad debts and other credit collection expenses.
- (d) *A percentage of works cost* : This is often used for apportionment of fixed selling and distribution costs.
- (e) *A percentage of stock of finished goods*
- (f) *According to the number of orders.*
- (g) *According to the number of invoices.*
- (h) *A percentage of value added* (i.e. total sale minus cost of materials).

The best method is to analyse each item of expense and allocate it to different products on the basis of services rendered.

Analysis of selling and distribution overhead by products, methods of sales etc. offers the following *advantages* :—

- (i) Profit or loss may be computed for each product, for each method of sale, and for each type of customer. Remedial action may be taken by concentrating efforts on less profitable lines or by altogether dropping out such lines.
- (ii) Excessive selling and distribution costs against a particular product or type of customer may be curtailed.
- (iii) Selling prices may be adjusted with reference to the selling and distribution services needed by each line.

An illustration showing analysis by products and the net profit from each product is given in Fig. 5.4. The figures for the West Zone have been taken and

it has been assumed that only three products are sold in this Zone. Selling and distribution costs have been apportioned to the three lines on the basis of sales value.

Profit and Loss Statement

Zone : *Western*

Period : *January, 19 ..*

	Total Rs.	Product B1 Rs.	Product B2 Rs.	Product B3 Rs.	Basis of apportionment
Sales	40,000	20,000	12,000	8,000	Actual
Factory cost	24,000	12,000	8,000	4,000	Actual
Administration Overhead	2,400	1,200	800	400	
Selling and Distribution Overhead	11,750	5,875	3,525	2,350	On the basis of sales value
Total cost	38,150	19,075	12,325	6,750	
Net Profit	Rs. 1,850	925	(—) 325	1,250	

Fig 5.4. Analysis of Profit and Loss by Product

Another example is given below to illustrate the methods of analysis discussed in the foregoing sections.

EXAMPLE 5.1.

A company manufactures two models of a machine and distributes them in three sales areas. The budgeted profit and loss account for a year is

Sales :			
Area	Large Rs.	Small Rs.	Total Rs.
A	12,500	25,000	37,500
B	25,000	37,500	62,500
C	37,500	62,500	1,00,000
	75,000	1,25,000	2,00,000

Production cost of sales :

Large (60% of sales)	45,000	
Small (70% of sales)	87,500	1,32,500
		67,500

Gross Profit

Direct selling and distribution costs :

Area	A Rs.	B Rs.	C Rs.	Total Rs.
Salesmen's salaries	3,625	4,000	1,875	9,500
Salesmen's expenses	1,125	750	625	2,500
Sales office costs	1,750	1,550	1,200	4,500
Advertising	350	850	400	1,600
Carriage	675	600	725	2,000
				20,100

Indirect selling and distribution costs :

Advertising	Rs. 6,000		
Carriage	Rs. 1,100		
Warehousing	Rs. 3,850		
Credit control	Rs. 2,200		
General administration	Rs. 4,000	17,150	
			Rs. 37,250
Budgeted net profit			Rs. 30,250

The budgeted analysis of sales is :

Sales area	Large		Small	
	Sales volume (machines)	No. of orders	Sales volume (machines)	No. of orders
A	2,000	300	2,000	400
B	4,000	500	3,000	500
C	6,000	200	5,000	300

The cost manual of the company states that :

- (i) Indirect selling and distribution costs are to be apportioned to sales as follows :-
 Advertisement and general administration : On the basis of sales value
 Carriage and warehousing : Sales volume
 Credit control : Number of orders

- (ii) Selling and distribution costs of sales areas are to be apportioned to models on the basis of sales value.

You are required to :

- (a) Prepare a comparative statement showing an analysis of budgeted selling and distribution costs by sales areas ;
 (b) Prepare a comparative budgeted profit and loss statement for each model by sales areas ;
 (c) Show the budgeted average net profit per unit for each model in each sales area

(I. C. M. A., Pt. II—Adapted)

ANSWER :**Analysis of budgeted selling and distribution costs by sales areas**

Cost		Total Rs.	Areas		
			A Rs.	B Rs.	C Rs.
<i>Direct</i>					
Salaries		9,500	3,625	4,000	1,875
Salesmen's expenses		2,500	1,125	750	625
Sales office costs		4,500	1,750	1,550	1,200
Advertising		1,600	350	850	400
Carriage		2,000	675	600	725
Total		20,100	7,525	7,750	4,825
<i>Indirect</i>					
Apportionment basis		Total Rs.	Areas		
			A Rs.	B Rs.	C Rs.
Advertising	Sales value	6,000	1,125	1,875	3,000
Carriage	Sales volume	1,100	200	350	550
Warehousing	Sales volume	3,850	700	1,225	1,925
Credit control	No. of orders	2,200	700	1,000	500
General administration	Sales value	4,000	750	1,250	2,000
Total		17,150	3,475	5,700	7,975
Grand total		37,250	11,000	13,450	12,800

Comparative profit and loss statements for each model, sales area-wise

Areas	Large			Small		
	A Rs.	B Rs.	C Rs.	A Rs.	B Rs.	C Rs.
Sales	12,500	25,000	37,500	25,000	37,500	62,500
Product cost	7,500	15,000	22,500	17,500	26,250	43,750
Gross Profit	5,000	10,000	15,000	7,500	11,250	18,750

Selling and distribution costs

(Apportionment of area costs to models on the basis of sales value*)

Salesmen's salaries	1,208	1,600	703	2,417	2,400	1,172
Salesmen's expenses	375	300	234	750	450	391
Sales office cost	583	620	450	1,167	930	750
Advertising (direct plus indirect)	492	1,090	1,275	983	1,635	2,125
Carriage (direct plus indirect)	292	380	478	583	570	797
Warehousing	233	490	722	467	735	1,203
Credit control	233	400	188	500	600	312
General administration	250	500	750	500	750	1,250
Total	Rs. 3,666	5,380	4,800	7,334	8,070	8,000
Net Profit	Rs. 1,334	4,620	10,200	166	3,180	10,750
Sales units	2,000	4,000	6,000	2,000	3,000	5,000
Net profit per unit	Rs. 0.667	1.155	1.7	0.083	1.06	2.15

*Apportionment of sales area costs to the products in made in the following ratios

Area A Large : Small : : 12,500 : 25,000 i.e. 1 : 2

Area B Large : Small : : 25,000 : 37,500 i.e. 2 : 3

Area C Large : Small : : 37,500 : 62,500 i.e. 3 : 5

Comparison of Selling and Distribution Costs Analysis with the Accounting of Manufacturing Overhead. We have seen that the basic techniques of analysis of selling and distribution costs are similar to those adopted for the accounting of manufacturing overhead. Some of the differences underlying the costing procedures of these two categories were stated earlier. The differences which arise mainly due to basic difference in the characteristics of the two types are summarised below :

- Analysis of selling and distribution costs is more in the nature of statistical costs. The analysis is not ordinarily tied up with the accounting records but is operated outside the books of accounts.
- It is difficult to set up standards for most of the selling and distribution costs. As a result, the analysis of such costs is mainly historical.
- Selling and distribution costs are charged to cost of sales only. Any unallocated cost is taken as reduction of the profit for the period. If, however, an expenditure relates to jobs made to order, it may be charged to manufacturing overhead.

- (d) Unlike the accounting for manufacturing overhead, the analysis of selling and distribution overhead cannot be considered to be a continuous process of accounting. In those organisations which do not need such an elaborate process of analysis of selling and distribution costs for the purpose of control, the analysis may be made intermittently as and when desired.
- (e) Manufacturing overhead is allocated and apportioned to cost centres but cannot be normally charged direct to cost units like products, processes, and jobs. Selling and distribution costs are apportioned as well as directly allocated to products and also to customers, territories, salesman, etc.

Control of Selling and Distribution Overhead. There are certain special features attached to selling and distribution costs (some of these have already been discussed) which make their analysis more detailed and exacting with the result that their control is rendered comparatively difficult. In most cases, it is not possible to directly identify or link selling and distribution costs with units of production because the costs are generally incurred after production has been completed. The incidence of selling and distribution overhead depends upon several outside factors, like distance of market, terms of sale, and extent of competition, due to which fixation of standards for certain items of expenses becomes difficult.

The main *problems* involved in the control of selling and distribution costs are as follows :—

- (i) There is no control over customers and competitors.
- (ii) The capacity of a sales organisation cannot be properly defined.
- (iii) Staff and representatives employed outside are not susceptible to control due to lack of direct supervision. This necessitates the use of incentive systems for remunerating such staff.
- (iv) Market price may be established without reference to the cost of production of the individual business.
- (v) Data regarding market operations are difficult to obtain.
- (vi) Capacity of the market cannot be accurately determined.
- (vii) Sometimes the difference between making or not making a sale is not apparent or clear.

Many of the items of selling and distribution overhead are in the nature of policy costs or discretionary costs which are largely uncontrollable at the lower levels of management. As in the case of other elements of costs, the control of selling and distribution overhead may be effected, either without a predetermined plan by comparison with past actuals, or with the help of budgets and standards.

Comparison with past performance : The expenses for a period are suitably analysed and each item is compared with the corresponding expenditure incurred during an earlier period. The comparison may be made between the amounts

incurred in the two periods, or between the percentages of the expenses to the sales volumes in the respective periods.

This is only a rough and ready method and has little practical value in large concerns incurring large amount of expenditure. There being no suitable target for measuring performance, no effective conclusion can be arrived at.

Budgetary control : The method is similar to that adopted for the control of manufacturing overhead. The expenses are segregated into fixed and variable, i.e. the overhead costs that are incurred whether or not any sales are effected are separated from those costs which vary with the various levels of sales and the actual selling and distribution costs incurred are compared with the budgets.

Standard costs : These are dealt with in Chapter 12.

Treatment of Certain Items of Selling and Distribution Overhead. The problems involved in the accounting of some of the items of selling and distribution overhead are discussed in the following paragraphs.

Advertisement (Sales Promotion) : In many undertakings, advertisement costs constitute a significant portion of the selling expense. If advertisement is on general lines meant to increase the demand for all the products of the concern, the expenditure is treated as selling overhead and recovered in the cost of goods sold, by one of the methods already described.

The cost of advertisement for individual products is also an item of selling overhead but the expenditure in such cases is directly allocated to the product concerned. When a combined advertisement is meant for more than one product, apportionment of the cost is made to the various products on the basis of sales turnover or any other technical assessment that the management considers suitable.

Heavy advertisement costs, the effect of which is felt on future sales, should be deferred and charged to the goods sold in the future periods. Advertisement costs which benefit the current sales are charged to the accounts for the current period and the balance amount, which is deferred to the subsequent accounting periods, may be charged either on the production of a future limited period or on a specified quantity to be manufactured in the future. In certain cases where the advertisement is of a permanent nature, e.g. permanent neon signs or hoarding sites, the cost should be capitalised and its depreciation charged to selling overhead.

Incidentally, all advertisements are not part of sales promotion campaign but they may be necessary for the efficient management of the business. Advertisement may be required for staff recruitment, opening of new offices, change of telephone numbers, etc. Some of the advertisements have the character of a statutory requirement, e.g. notices in respect of closure of share transfer books, calling of meetings of shareholders, notices of legal proceedings, etc. All these expenses are treated as administration overhead. Advertisement regarding invitation of tenders in connection with purchases may be treated as purchase department costs.

An example illustrating the apportionment of advertisement costs to products is given on the next page.

EXAMPLE 5.2

A company is producing three types of products, A, B, C. The sales territory of the company is divided into three areas X, Y and Z. The estimated sales for the year are as under :

Product	Territories		
	X	Y	Z
	Rs.	Rs.	Rs.
A	50,000	20,000	
B	30,000	—	80,000
C	—	70,000	40,000

Budgeted advertising cost is as under :

	Territories			Total
	X	Y	Z	
	Rs.	Rs.	Rs.	Rs.
Local cost	3,200	4,500	4,200	11,900
General		—		5,800

You are required to find the advertising cost per cent on sales for each product and territory showing how you will present the statement to management (I. C. W. A., Inter)

ANSWER :

General advertising cost of Rs. 5,800 is allocated to territories on the basis of sales value, as follows :—

	Sales value		General advertising cost	
	Rs.	Rs.	Rs.	
Territory X : Product A	50,000		1,000	
B	30,000		600	
		80,000		1,600
Territory Y : Product A	20,000		400	
C	70,000		1,400	
		90,000		1,800
Territory Z : Product B	80,000		1,600	
C	40,000		800	
		1,20,000		2,400
				Rs. 5,800

Local costs allocated to territories are apportioned to products on the basis of sales value

Territory X : Product A	50,000		2,000	
B	30,000		1,200	
		80,000		3,200
Territory Y : Product A	20,000		1,000	
C	70,000		3,500	
		90,000		4,500
Territory Z : Product B	80,000		2,800	
C	40,000		1,400	
		1,20,000		4,200

Statement of advertisement cost :

	Territories			Total	% on sales
	X	Y	Z		
	Rs.	Rs.	Rs.	Rs.	
Product A	3,000	1,400	—	4,400	6.28
B	1,800	—	4,400	6,200	3.64
C	—	4,900	2,200	7,100	6.45
Total	Rs. 4,800	Rs. 6,300	Rs. 6,600	17,700	6.10
% on sales	6.00	7.00	5.50	6.10	

In many organisations advertising costs constitute a major portion of marketing costs and numerous methods and types of media are used for advertising a company's products and services. Despite its size and importance, it is not always possible to measure the effectiveness of the amount spent on advertising and as such, a proper cost benefit analysis of advertising is often rendered difficult. The reasons are :

- (i) There is a time lag between the incidence of advertising costs and the benefits achieved. The time lag is more prominent in cases of long term advertising plans where the benefits come much later.
- (ii) The benefit of advertising is sometimes not apparent. In certain cases, the benefit may be insignificant or even nil. For instance, simultaneous sales campaign by one or more competitors may nullify the effect of a company's advertisement.
- (iii) The benefit, say increased sales, may be achieved through the operation of factors other than advertising ; it is difficult to segregate the benefits of these factors from the benefits obtained through advertising.
- (iv) It is likely that advertising may not create additional demand but it may merely advance the timing of sales.
- (v) General economic conditions in the country may influence the effectiveness of advertising.

It is, therefore, essential to keep the above points in view for an effective cost benefit analysis of advertising. The two important aspects to be considered are : (i) the identification and segregation of the other factors creating increased sales demand, and (ii) computing the *present value* of the benefits, if the time lag between cost and benefit is significantly long.

Control of advertising costs through budgets is discussed in Chapter 11.

Bad Debts : Opinions differ with regard to the treatment of bad debts. One view is to exclude bad debts from costs on the ground that these are income due but not realised and are, therefore, financial losses only. If, however, it is decided to include bad debts in costs, the method of treatment will depend upon the position of the Billing or Credit Collection Department in the organisational set up of the undertaking ; the expenditure will be treated as selling overhead, if this department is under the control of the Sales Department. In case billing and credit collections are the responsibility of the Accountant or the Secretary, bad debts are charged to administration overhead. Heavy bad debts which are of an abnormal or exceptional nature should not be charged to cost accounts.

Finished Stock Waste and Loss : This is treated as distribution expense. The loss of each product may be ascertained separately and allocated direct to individual product costs. Losses arising out of different causes should be distinguished. While unavoidable wastage due to inherent properties of the stock items such as shrinkage, evaporation, etc., and avoidable wastage due to faulty handling and storage may be included as part of distribution cost, abnormal waste and loss due to deterioration, obsolescence, and heavy damages should be written off to the Costing Profit and Loss Account or to the Profit and Loss Account, when the accounts are integrated.

Market Research Costs : Market research costs consist of expenditure incurred for a continuous study and exploration of the market for ascertaining the potential demand for a product or service and the factors that would stimulate the demand. The expenditure on market research is in the nature of policy costs, the amount of which would vary in accordance with the policy of the management. The function of market research includes the study of potential markets, area analysis (i.e. study of sales in each market), future trends of consumers' size in population and their tastes and habits in different areas, study of competitors' participation and competitive products, channels of distribution, trading practices, etc. Market research is a specialist's function ; its cost is normally included under selling overhead and accounted for in the usual manner.

Packing Costs : Packing for products may be of the following three types :—

- (i) Ordinary or primary packing which is necessary for protection and convenient handling of the product. The cost of such packing is included in manufacturing costs as prime cost.
- (ii) Cost of packing which facilitates transportation of the product from the factory to the consumer is distribution cost. Cost of special packing at the customers' request may, however, be charged to the specific
- (iii) Fancy packing, meant to attract customers is a form of advertisement the cost of which is treated as selling overhead.

Packing department overhead which cannot be directly allocated may be suitably apportioned to the above-mentioned three functions. The next step is to apportion the cost to the various products. This may be done on the basis of time or labour cost of packing utilised by each product. If that is not practicable, the sales values of the products may be adopted as the basis.

Post-sales Services : Some concerns offer continued free services during a stipulated guarantee period after sales. Sometimes, parts and components are also replaced free of cost. The expenditure on this account includes cost of spare parts and materials, salaries, wages, and travelling expenses of the service staff, and overhead pertaining to the servicing department. Such expenses are treated as selling overhead.

For control purposes, the expenditure on post-sales services may be analysed and investigated. Free replacement of parts may be charged to the manufacturing department responsible, damages in transit may be charged to the delivery department, defects in designing to the design department, and so on.

Royalties and Patent Fees : Payments of royalties and patent fees may be made periodically as a fixed charge just as rent or they may be based either on the units sold or on units of production. If based on sales, the expenditure is charged to selling overhead. If payment is made in the form of rental or if it is based on units produced, the expenditure is treated as an item of factory overhead. In the latter case, it may also be taken as a direct charge to the cost of production.

Salesmen's Remuneration : Remuneration paid to salesmen and sales agents comprise salary, commission, and travelling expenses. With reference to the volume of sales, remuneration may be divided into two parts, viz. the fixed or indirect expenses such as salary, and the variable or direct expenses such as commission. Commission is paid either at a fixed percentage for all products or at varying percentages for individual products. In both cases, the expenditure is directly allocated to the products. If the rate of commission is not uniform but varies with each transaction, the expenditure involved is treated as an item of general selling overhead and accounted for in accordance with the methods previously discussed.

Transit Insurance : The amount of premium covers the risk of goods lost while in transit. If the insurance relates to more than one product in transit, the total amount involved may be apportioned on the basis of the value of the merchandise, taking into account the transit distance involved. If the premium is based on finished stock, the amount may be apportioned on the basis of the value of sales.

Warehouse Rent : A convenient basis of apportionment of warehouse rent is the floor area or volume occupied by each item of warehouse stock, or the number of packages if they are of uniform size. If this basis is not firm and is impracticable, technical estimation should be made of the weight of the particular products lying in the warehouse and the time or period of storage.

Warehouses established by a company in various locations near the market meet the purpose of serving the customer in a quicker and better way. With large number of warehouses, emphasis is laid on greater and prompt availability of products but at the same time this results in the increase of physical distribution costs in the shape of inventory holding costs, warehousing costs, transportation costs, and order processing and handling costs. A cost benefit analysis is, therefore, necessary, to determine the cost effectiveness of moving and keeping stocks of products nearer to the market.

Products are often transported from one or more plants to a number of warehouses situated in different markets, each movement involving a different transportation cost. The problem involved in such a case is to evolve a transportation schedule that would meet all demands from current inventory at a minimum total transportation cost. These aspects are discussed in Chapter 19, in which we deal with Linear Programming-Transportation Problems.

Market Segmentation. Market segments are subdivisions of a market into homogeneous meaningful customer groups for the purpose of guiding market strategy. Market segments may be organised according to products, types and sizes of customers, geographical territories, salesmen, channels of distribution etc. Each segment is considered to be a distinct entity which helps in locating and comparing marketing opportunities. Customer satisfaction, extent of current demands, the operation of competitive process, and such other related factors may be studied market segmentwise so that the needs of each segment may be identified and action taken accordingly. For instance, steps may be taken to : improve under-developed segments, adopt differential policy for each segment (say, by

leaving out the saturated segment), concentrate marketing policy on few lucrative segments when resources are limited, and make effective cost benefit analysis for each segment.

Analysis of Sales. Sales may be analysed in a number of ways and according to market segments. The analysis may take the form of sales over a number of periods : this would reveal trends, periodic or cyclic movements, seasonal or fluctuating characteristics, etc. and assist in formulating sales policy on a long term basis.

The methods of sales analysis according to the different types of market segment and the purpose served by each are discussed below :

- (i) *By salesmen* : The turnover for each salesman is ascertained so that :
 - (a) actual sales may be compared with past period sales, budgeted sales or sales quota (in the absence of budgets), or the performance of one salesman may be compared with that of another and corrective action taken where necessary,
 - (b) volume of sales may be compared vis-a-vis the selling costs for the purpose of controlling the latter, and
 - (c) useful data may be provided for fixing sales commission and bonus payable to salesmen.

The methods of evaluation of performances of salesmen are discussed in the next section.

- (ii) *By sales territories* : The volume of sales is analysed according to the territory so that :
 - (a) comparison may be made with budgets, i.e. the potential sales of the territory,
 - (b) the contribution of each territory to the net profits of the company may be determined,
 - (c) selling and distribution cost may be controlled by co-relating them with sales volume, and
 - (d) the market research workers may assess the extent of penetration of competitors in the field.
- (iii) *By product or product lines* : Such an analysis has the following uses :—
 - (a) The net profit for each product is ascertained and compared with past data for control purposes.
 - (b) Production is planned according to profitability. This assists in deciding upon the product mix ; weak lines may be strengthened, reduced, or discarded altogether.
 - (c) The trend of sales of each product is ascertained.
 - (d) It assists in the control of selling and distribution costs by linking them with the sales volume for each product.
- (iv) *By customers* : This serves the following purposes :—
 - (a) Net profit is ascertained by each type of customer.
 - (b) Data is provided for maintaining a reasonable balance between the various types of customers and for determining the extent of discount to be allowed to each.

- (c) Customer-wise sales potential may be ascertained so as to help in future sales drive or to find out the effect of a programme of sales promotion already undertaken.
- (v) *By channels of sales* : The use to which such an analysis may be put to are as follows :—
 - (a) The profits for various channels, e.g. wholesale, retail, export, etc. may be ascertained.
 - (b) the relative viability of each channel can be assessed. This helps in planning future policy regarding the various channels.
- (vi) *By size of orders* : This would be useful in the following manner :—
 - (a) Cost of handling and transportation may be compared with the sales volume of the various sizes.
 - (b) Trade discounts on quantity for the various sizes may be decided upon.
- (vii) *By unit price* : This analysis gives information regarding price trends that may be useful for formulating price policy.
- (viii) *By periods* : Comparison of sales over a number of periods :
 - (a) reveals trends, periodic, or cyclic movements, seasonal or fluctuating characteristics, etc., and
 - (b) assists in formulating sales policy on a long-term basis.

Evaluation of Performance of Salesmen. Salesmen (for the purpose of evaluation of performance, we shall take this term to include selling agents, sales offices, regional sales offices etc.) are the kingpin in the marketing policy and programme of a company and much of the company's success of the marketing strategy depends on the efficiency of its salesmen. It is but natural, therefore, that the management would like to keep a close watch on each salesman and evaluate his performance in order to know his individual worth. As already stated in the previous section, the evaluation of salesmen is made by developing suitable standards against which the performance of each salesman would be judged, just like the method we adopt for the evaluation of performance of the managers in the other sectors of the organisation. The standards or targets for this purpose may be one or more of the following :—

- (i) Sales achieved (Sales turnover) :
- (ii) Gross profit or contribution on sales :
- (iii) Percentage of sales quota achieved :
- (iv) Number and volume of new business obtained or business lost :
- (v) Number of calls made.

The particular target or targets established will vary from company to company depending on the circumstances relevant to the issue. Most companies use sales turnover (item (i) above) as a yardstick for evaluating the performance of their salesmen. Sales turnover, however, may not be at times a satisfactory yardstick for the purpose. A salesman may show a high turn-over to his credit by concentrating on quick selling products with low contribution margin neglecting the high contribution margin products which may be comparatively difficult to sell.

An illustration to demonstrate the evaluation of performance of salesmen is given below :

EXAMPLE 5.3

A company manufacturing a number of brand products sells them through four selling agents appointed for the four different sales territories of the company, E, N, S and W. The company has fixed selling prices for each of the products but the selling agents have been allowed the freedom to offer discounts or charge 'extras' from the customers within $\pm 1\%$ to $\pm 5\%$ of the stipulated prices, at their discretion. All discounts and extras are passed on to the company's account. The selling agents get, besides the fixed monthly salaries, a commission of 5% on the value of orders booked in a month. Monthly sales quota are fixed for each selling agent.

The actual data for a particular month were as follows —

Selling agent	E Rs.	N Rs.	S Rs.	W Rs.
Commission paid	1,245	1,497.50	1,393.75	1,520
Standard cost of sales quota for the month	12,500	12,000	12,000	18,000
Sales variance				
Volume	100 F	100 A	100 A	200 F
Price	200 A	50 F	25 A	200 F
Contribution margin variance (price)	1,500 F	1,000 F	600 A	800 F

You are required to evaluate the performance of each selling agent on the basis of actual contribution made, and rank them accordingly. How does the ranking differ from the ranking on the basis of orders booked and why? (F Favourable A Adverse)

ANSWER .

The actual marginal contribution made by each individual selling agent is computed as follows :—

Selling agent	E Rs.	N Rs.	S Rs.	W Rs.
Commission paid	1,245	1,497.50	1,393.75	1,520
	20	20	20	20
Total orders booked	24,900	29,950	27,875	30,400
Sales variance				
Price	200 A	(—) 50 F	25 A	(—) 200 F
Volume	(—) 100 F	100 A	100 A	(—) 200 F
Sales quota for the month	25,000	30,000	28,000	30,000
Standard cost of quota sales mix	12,500	12,000	12,000	18,000
Contribution mix variance	1,500 F	1,000 F	(—) 600 A	800 F
Actual contribution	14,000	13,000	11,400	18,800
Ranking on contribution basis	II	III	IV	I
Ranking the basis of orders booked	IV	II	III	I

While W territory ranks first both according to contribution and total sales orders booked, the ranking in respect of the other territories on the two bases differs. This is because the contribution margin of the various products are different and so are the sales mix for each territory. Thus, although N has booked orders which have a total value less than that of W only, the sales contribution margin is low compared to E which has the least sales turnover.

Evaluation of Distribution Alternatives. In the present day marketing strategy, the products of a manufacturer, producer or seller reach the consumers through a series of middlemen or intermediary agencies, commonly termed as distribution channels. These channels to mention a few, are : wholesalers, retailers, selling agents, commission agents, distributors, bankers, discount houses, etc. The marketing manager frequently changes over from one distribution channel to another for improving sales, providing more effective customer service and for various such reasons. In these circumstance, he would like to have a cost benefit analysis of the feasible alternatives to enable him to select the best possible distribution channels. Thus evaluation of distribution alternatives has an important role to play in marketing strategy.

Each distribution system produces a different level of sales (and so, different levels of related profits) and incurs different distribution costs. The main objective of evaluation of distribution alternatives is, therefore, to determine the one which will bring in the highest profits through maximisation of sales by incurring the least costs. The process of evaluation primarily constitutes a consideration of the relationship between the sales volume and the related costs for each alternative.

In the process of evaluation, the sales under each of the proposed systems are estimated in the first place. In the next step, the distribution costs for the alternative channels are estimated. The costs for this purpose will consist of not only the costs directly allocated to the particular channel but will also include a share of the common distribution costs apportioned to that channel. Cost analysis of the alternative channels may be made by computing the rate of return as illustrated in the following chart :

	Channel I	Channel II
	Rs. (lakh)	Rs. (lakh)
Estimated sales, S	30.00	45.00
Estimated distribution costs, C	1.00	1.75
Return on investments, $(S - C) / S$	$29.00 / 1.00 = 29$	$43.25 / 1.75 = 25$ (approx)

On the above basis, Channel I yielding a higher return will be preferable. A decision will, however, be taken after also considering the non-cost factors involved. Two such factors are the control aspect and the flexibility aspect : the channel which is more susceptible to control (e.g. own sales staff compared to outside agency) will be preferable and a channel which is more flexible, i.e. the one that can be changed easily without binding the company on a long-term basis to a particular channel, will be a better choice.

The sales-cost analysis of the alternatives may also be made in the break-even form by plotting a chart (Fig. 5.5) showing costs at different sales levels for each alternative. It may be noted that the break-even chart shows clearly the difference in the fixed distribution costs involved under the alternative channels. While at break-even sales, the costs involved for both the channels would be the same, Channel I is preferable when sales are expected to fall below the break-even point and Channel II is suitable if sales go above the break-even point.

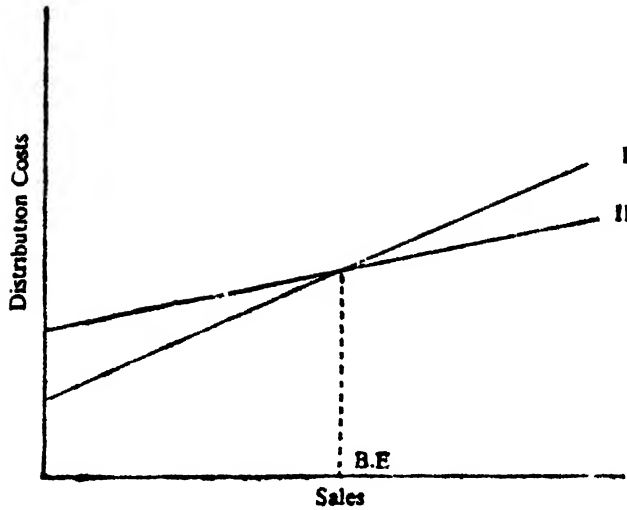


Fig. 5.5. Break-even chart for distribution alternatives

RESEARCH AND DEVELOPMENT COSTS

Research cost is defined as the cost of searching for new or improved products, new applications of materials, or new or improved methods, processes, systems or services. Research may be carried out departmentally by the research staff of the organisation or it may be entrusted to outside associations. On the other hand, there may be companies whose business regularly includes undertaking of contracts in the nature of research and development work. The cost of research includes the cost of initial experimentations, tests, and subsequent small scale trial runs to prove the results of research. The expenditure is normally comprised of wages and salaries of the research and testing staff, materials and facilities utilised in laboratory and research department, payment to outside organisations, etc. Research may be of the following types :—

- A. *Pure or Basic research* to gain general know-how regarding production or market, not directed primarily towards any specific application.
 - (i) *General research* not connected with any specific product. The benefit of such research cannot be assessed against particular products.
 - (ii) *Routine research* or tests for quality and specifications of input and output.
- B. *Applied research*, which applies basic research knowledge in practice :
 - (i) Research for improvement of existing products, methods, or equipments.
 - (ii) Research for exploring or establishing new products, processes, methods, or equipments which offer opportunity for more profits.
 - (iii) Research for providing improved measures of safety, health, and convenience.
 - (iv) Research for raw material and other resources utilisation.
 - (v) Research into human relations and management of men.

Development cost is the cost of the process which begins with the implementation of the decision to use scientific or technical knowledge to produce a new or improved product or to employ a new or improved method, process, system etc. and ends with the commencement of formal production of that product by that method.

Development starts where research ends ; development expenditure is the cost incurred for putting the results of research on a practical commercial basis. To take an over-simplified example, research reveals that it is scientifically and technologically feasible to manufacture a particular product in accordance with a specified design. Development is the next stage when laboratory and feasibility studies are made and a trial (or make-up) pilot or proto-type run is made. A small unit of the product is manufactured under practical production conditions in order to test whether large scale manufacture would be commercially sound. Only after this test is successful, full scale production is undertaken. Thus, development forms a bridge between research and production though it is more akin to the latter. The fruits of research are passed on to development and the results obtained from development work are passed on to benefit production. However, the functions of development and research, particularly applied research overlap sometimes and since it becomes difficult to draw a line between the two, the terms are often used synonymously.

Special Features of Research and Development Cost. There are certain features attached to research and development which should be carefully studied before attempting to evolve a suitable system for the accounting and control of research and development expenditure. These *features* are :

- (i) Expenditure is incurred ahead of actual production and may not, therefore, be charged to current production.
- (ii) The amount of expenditure may often be substantial.
- (iii) The expenditure may at times be entirely infructuous, the research being unsuccessful, yielding no tangible result.
- (iv) Benefit of research and development is felt over a number of future years.
- (v) Difficulty in fixation of proper standards for control of research and development expenditure.
- (vi) The objects for which research and development is undertaken are varied and, therefore, different accounting treatments are required for different circumstances.

In the prevailing competitive conditions, research and development is essential not only for the growth of a business but sometimes, even for its very survival. Continuous research and development is being carried out in a large number of industries which spend large sums on it.

Purpose of Research and Development. The various purposes for which research and development is carried out are :

- (a) To acquire better basic knowledge and know-how ;
- (b) To create new products, processes, services, and equipments so as to improve the company's financial position by maximising profit ;

- (c) To improve upon the existing products, processes, etc. with a view to retaining or enlarging profits by keeping the products competitive in quality and price and by making them more acceptable to the market ;
- (d) To find new uses for products, processes, etc. ;
- (e) To improve the organisation and layout of the business ;
- (f) To explore possibilities of obtaining and retaining a larger market ;
- (g) To find better methods of service to customers ;
- (h) To search for opportunities of expansion into other fields which may or may not be related to the present business. The intention, of course, is to increase profits through such diversification.

Accumulation of Research and Development Expenditure. Accumulation of research and development expenditure is essential for the following reasons :

- i) for review of costs to date vis a vis future sales and profits ;
- ii) for planning the activities subsequent to research, e.g. development, pilot run and marketing ;
- iii) for evaluation of performance with relation to past performance or performance of another unit (inter-firm comparison).

The collection of research and development costs is made through the usual primary documents like materials requisitions, labour time cards, invoices, and vouchers. The vouchers record special items, e.g. royalty, patent right, and cost of rectification.

Research and development expenditure may be identified by its nature, i.e. basic or applied research or development, by the elements of cost, by business sector and by project. Each research and development project is allotted a project work order number. Separate series of work orders or suitable codes should be used to distinguish each class or type of research and development expenditure. All expenditure under the direct elements, viz. materials, salaries and wages, and direct allocatable costs are booked to the respective work orders. Some of the expenses like special staff, supervision, handling expenses, and equipment maintenance can be directly allocated to particular research and development order. Fixed costs, e.g. depreciation, insurance, rates, and taxes are accumulated and prorated to the various orders on a suitable basis. Items of general overhead such as proportionate share of purchase department expenses and general maintenance may also be suitably apportioned to each research and development project on a reasonable basis. Expenditure on basic research projects which are in the nature of theoretical, academic, or educational research costs should also be accumulated under separate work order numbers but no portion of the general overhead should be charged to these projects. The expenditure on such projects is in itself an item of overhead cost which should be equitably apportioned.

Accounting of Research and Development Costs. The problems encountered in the accounting of research and development costs arise due to the following causes :

- (i) The expenditure is in the nature of pre-production costs and there is a considerable time lag between the incidence of expenditure and realisation of the benefit.

- (ii) There is no immediate production, or the production is so small that it becomes difficult to charge such costs to products.

It is because of these difficulties that the accounting of research and development costs has been a subject of some controversy. Three methods are available for charging research and development costs, viz.,

- 1 *Charge off to costs of the current period on revenue basis.*
- 2 *Capitalisation, so that the costs may be amortised on a long term basis.*
- 3 *Deferment and charge off to costs of the next two or three years—a short-term amortisation.*

Research and development costs may be regarded as a function of production and they may be charged to cost of goods sold by direct allocation to specific products or treated as overhead costs to be recovered through the general overhead rates.

There are various arguments for and against charging research and development costs in current revenue. Whether an item of research and development cost should be capitalised or charged to revenue accounts depends upon two factors, viz. the nature of expenses included in the costs and the objective and likely results of the research and development. Research may be *basic*—the aim is not for benefiting a particular product but to contribute to the general efficiency and growth of the business. Research and development may also be undertaken with a view to bettering the results in the factory (and also in the office) by finding out improved materials, methods, processes, handling methods, plant layout, etc. and for developing additional or new products. The conservative view is to charge off these costs to current revenues, particularly in the case of general research which does not result in products, either at present or in future. The arguments in support of this method are as follows : —

- (a) All research and development expenses do not result in new processes or saleable products.
- (b) Some of the research and development projects may result in failures.
- (c) These expenses may be incurred simply to maintain the present competitive position of the concern.
- (d) It is difficult to assess the period over which the know-how or knowledge acquired may be spread over.
- (e) It may be more advantageous to recover a substantial portion of the cost immediately, particularly in the case of new products whose future sales may drop once the novelty wears off and competition sets in.
- (f) In certain cases, the effect of these costs on future revenues may be doubtful.

When research and development is directed towards a specific product or process, existing or future, but it is not considered desirable to add the expenditure to the cost of products, there being no production or very little production in the current period, the expenditure may be capitalised. If the benefits of the research and development are to be derived in subsequent periods on a long-term basis, the expenditure may be capitalised and an amount charged to the costs every year in a manner similar to the charging of depreciation. In case, however, it is considered desirable to recover the cost over a short term of two or three years, the same may

be treated as a deferred cost. This method is thus a compromise between an immediate charge to revenue and the long-term capitalisation. The expenditure is treated as fictitious asset and carried over in the Balance Sheet for amortisation in subsequent years.

The arguments advanced in favour of amortising research and development expenditure (which incidentally, are the points against the procedure for charging to current revenues) are summarised below :

- (a) The increase expected in the earnings in the future is due to the efforts of research and development and so future periods should bear a legitimate share of such expenses.
- (b) Charging the expenses in the current period results in wide fluctuations in costs and profits.
- (c) When a patent results from research and development, it is but reasonable that the cost of the patent should be amortised in future years which receive benefit from it.
- (d) It is not correct to charge expenses not directly related to current activity, to current costs and profits.

The methods of accounting of research and development costs in specific situations are discussed below :

General (i.e. Basic) research costs : These are not linked with any particular product, equipment, or method, etc. Further, the results of such research are not definite—the benefit may be felt in the same year or in subsequent years, or the research may not yield any fruit at all. General research costs are treated as items of overhead ; research cost on products or on methods of manufacture is treated as factory overhead, market research as selling overhead, and research on administration and management as administration overhead. For control and accounting purpose, each item of general research cost is allotted a Standing Order Number. As in the case of repair and maintenance costs, a fixed amount for research and development may be provided in the accounts against which the actual expenditure incurred is set off.

Costs of applied research : These can be allocated to the products for which they are incurred and are sometimes treated as pre-production costs. If costs are heavy and the result of such expenditure is likely to benefit production of future years, the costs may be treated as deferred revenue expenditure and apportioned prorata to future production. If the research is for the improvement of existing products or methods of production, the cost may be charged partly in the current year and partly deferred, if necessary. Research cost incurred for asset improvement, i.e. for the purpose of increasing capacity or effective production capability of an asset, is capitalised.

Cost of development : This is treated in the same manner as applied research with the small difference that it is easier to link development with specific products, method or equipments. Most development expenses are heavy and because the quantum of production may not be sufficient to bear the charge during the development stage, development costs are deferred and absorbed in later periods. Sometimes, an amortisation fund is created and charged to future accounting periods, the charge to each period depending upon the size of production and what the traffic can bear.

Unsuccessful research and development : If such expenditure is normal and provided for in the budgets, it should be charged to overhead costs ; otherwise, it is written off to the Profit and Loss Account, as charging it to the cost of the period will vitiate costs. Pure research which is carried out continuously but does not give any tangible result should not be taken as unsuccessful and the cost of such research should be treated as an item of overhead.

The longer a project continues, the greater is the cost and higher the temptation not to abandon it. Decision to abandon a project should be taken at the right point of time.

Research and development on behalf of a customer : The cost of such research and development is either treated as overhead cost or charged to the customer's job.

Research and development for new products : If there is no production in the year, the expenditure is treated as deferred revenue. The expenditure is carried over as an asset in the Balance Sheet to be accounted for in the subsequent year(s) when production is established. If production has already started but is not sufficient to bear the entire expenditure of research and development, a portion of the expenditure is charged to current costs and the rest deferred.

Research and development for existing products : Such research and development is undertaken with a view to improving and developing the existing products by correcting defects, reducing waste, improving quality, etc. The expenditure on such schemes need not be deferred but should be charged to current costs, treating it as manufacturing overhead or selling overhead depending upon whether the research and development work is meant for improving production capabilities or for improving the volume of sales. The cost of incomplete research and development work should be carried over to the next year as work-in-progress, in a manner similar to the carry forward of incomplete projects in respect of new products.

EXAMINATION QUESTIONS

1. What are administrative expenses? Administrative expenses are generally apportioned to products either as percentage on production cost or as a percentage on conversion cost. Which of the two methods will you recommend for an engineering concern manufacturing a variety of products to customer's specification in both ferrous and non-ferrous metals? Give reasons why you consider the method recommended by you is the more equitable one. (I. C. W. A., Inter)
2. What problems are encountered in applying administrative costs partly to the manufacturing and partly to the selling departments of a concern? (I. C. W. A., Inter)
3. What are non-manufacturing costs? Give at least four illustrations of significant items of non-manufacturing costs in any factory known to you. Explain how these non-manufacturing costs are controlled. (I. C. W. A., Inter)
4. Your company directors feel that the administrative costs are high and still increasing. Prepare a suitable tabulation to bring out increase in cost in each function under administration and draft a report to the directors suggesting measures for the adequate control of administration cost. (I. C. W. A., Final)
5. Due to increase in the cost of administration in different directions, management is compelled to make improvements and economies. List some of the important directions in which administrative cost can be reduced, indicating the actions to be taken in implementing them. (I. C. W. A., Inter)

6. Due to heavy stockpiling to cover the requirements for three years, a manufacturing concern enters into a cash credit arrangement with its bank and pays heavy interest on the overdraft. Can this be absorbed in the manufacturing cost? If so, how? Give briefly your reasons. *(I. C. W. A., Inter)*
7. A departmental store offers a liberal discount on sales to the employees. Employees are eligible to buy from any department up to a certain limit depending on their salary. Hitherto, these discounts were treated as discounts on sales and classified as sales overhead.

The Sales Manager who has been appointed recently takes objection to this practice. He feels that discounts are legitimate labour costs pertaining to the departments in which the employees work and should be treated as overheads relating to the Personnel Division.

As a Cost Accountant of the company discuss the issue thoroughly and give your considered opinion. *(I. C. W. A., Final)*

8. A manufacturing and selling organisation comprises the following set-up :
 - (a) A sales department of its own, which lays down policy and looks after general sales promotion.
 - (b) A selling agent for the whole of India, who employs salesmen to collect orders and who covers the del credere risk of customers, against a 5% overall commission paid to him by the manufacturer.
 - (c) Distributors in some depressed districts in the north who are paid a commission of 6% by the manufacturer and are further aided by special advertising in these districts. Discuss the problems involved in computing selling costs in this organisation and the analysis required in order to bring out differences in selling costs in different areas. *(I. C. W. A., Final)*
9. Consumer Goods Ltd. manufacture four lines of products in their Calcutta factory and market them throughout India at fixed selling prices. Selling and distribution costs form a substantial part of the total cost.

Design a summarised statement to inform the managing director of the Company's monthly operating results. *(I. C. W. A., Final)*

10. The X Soap Co. manufactures slabs of washing soap for delivery to a central warehouse. Here they are wrapped in paper, packed in cases (12 dozens to a case) and despatched to the wholesalers in the city.

Make out a statement of packing and distribution cost for a month showing at least 10 items of cost and show the cost per case of soap. *(I. C. W. A., Final)*
11. A departmental store is organised into six major departments, each responsible for its own purchase and stocks subject to general management policy in regard to retail price mark up. The retail price mark up policy is to add the following percentages to purchase costs :

Utility goods	15% (this applies to four departments)
Luxury goods	30% (this applies to two departments)

Suggest a system for the computation of selling and administrative cost in this organisation and their levy to products in order to determine the profitability of different products and profitability of departments. *(I. C. W. A., Final)*

12. Electrical Products Ltd., Calcutta market their six different products through four regional sales offices in India. As the Cost Accountant to this company, you are required to prepare a statement showing the performance of each region for purposes of discussions at the Quarterly Regional Sales Managers' Conference. Prepare a proforma of such a statement adding a brief note on the salient points presented therein. *(I. C. W. A., Final)*
13. Distribution costs constitute a large proportion of the local marketing expense in certain organisation. Describe how you would control the cost of each aspect of distribution. *(I. C. W. A., Final)*

14. A manufacturing concern with a wide range of products seeks your assistance in controlling the selling and distribution expenses. Indicate any four major items of this nature and state how you will control them. *(I. C. W. A., Inter)*
15. A company maintains a market research and advertising department. The expenses for market research are of the order of Rs.10 lakhs a year and expenses on advertisement are of an equal amount. The company markets various types of consumer goods, such as wearing apparel, patent medicines, cosmetics, radiograms, etc. The modes of advertisement include audio-visual methods, free samples, gifts, etc. How would you apportion the expenses to the different lines of goods with a view to recovering the expenses from sales as well as to controlling the expenses? *(I. C. W. A., final)*
16. Define market research and discuss a Cost Accountant's contribution to such function in a sales organisation. *(I. C. W. A., Final)*
17. The expenditure on advertising is large and spread over a variety of forms of advertising. Give a layout of the form in which you would present a statement showing an analysis of such expenditure allocated to various products. *(I. C. W. A., Final)*
18. For purposes of product costing, explain how would you allocate or apportion each of the following items of overhead :
 - (a) traveller's salaries, commission and expenses ,
 - (b) after-sales service costs ,
 - (c) warehousing costs ;
 - (d) market research costs. *(I. C. M. A., Pt. II)*
19. Discuss briefly the main purposes of analysis of sales turnover. Prepare a sales and profit analysis statement, using suitable figures to bring out clearly the influence of product mix on profit. *(I. C. W. A., Final)*
20. What are the types of products which generally require after-sales service? What are the problems likely to be encountered in the recovery of after-sales service cost and how can these be solved? *(I. C. W. A., Final)*
21. How would you control the cost of post-sales service of domestic sewing machines which provides for replacement of defective parts and maintenance free of cost for two years and on a charge basis thereafter? *(I. C. W. A., Final)*
22. Beauty Aids Ltd. manufacture three different products and the following are the details of expenses incurred by them on advertisement during the year 1969 :—

(i) Exhibition stalls	Rs. 30,000
(ii) Sign boards and posters	Rs. 25,000
(iii) Neon lights	Rs. 20,000
(iv) Cinema slides	Rs. 10,000
(v) Brochures	Rs. 5,000
(vi) Newspaper advertisement	Rs. 5,000
(vii) Samples	Rs. 5,000

The sales turnover for the year were :

- Product A 50,000 units @ Rs. 10 a unit
 B 5,00,000 units @ Rs. 2 a unit
 C 1,00,000 units @ Rs. 15 a unit

Some of the above items of expenditure are incurred jointly for more than one product (e.g. exhibition stalls) whilst some others specifically for each product (e.g. sample). Prepare a statement showing the advertisement cost chargeable to each product for the year mentioning clearly the bases used for apportionment of expenses and any other assumption that you have made. *(I. C. W. A., Final)*

23. A company produces a single product in three sizes A, B, and C. Prepare a statement showing the selling and distribution expenses apportioned over these three sizes

applying the appropriate basis for such apportionment in each case from the particulars indicated. Express the total of the cost so apportioned to each size as—

(1) Cost per unit sold (nearest paisa)

(2) A percentage of sales turnover (nearest to two places of decimal)

The expenses are :

<i>Expenses</i>	<i>Amount Rs.</i>	<i>Basis of Apportionment</i>
Sales Salaries	10,000	Direct charge
Sales Commission	6,000	Sales turnover
Sales office expenses	2,096	Number of orders
Advertising : General	5,000	Sales turnover
Advertising : Specific	22,000	Direct Charge
Packing	3,000	Total volume in cft. of products sold
Delivery expenses	4,000	..
Warehouse expenses	1,000	..
Credit collection expenses	1,296	No. of orders
	<u>Rs. 54,392</u>	

Data available relating to the three sizes are follows :—

	Total	Size A	Size B	Size C
(i) No. Salesmen all paid salary	10	4	5	1
(ii) Units sold	10,400	3,400	4,000	3,000
(iii) No. of orders	1,600	700	800	100
(iv) Percentage of specific advertising	100%	30%	40%	30%
(v) Sales turnover (Rs.)	2,00,000	58,000	80,000	62,000
(vi) Volume of cft. per unit of finished product	—	5	8	17

(I. C. W. A., Inter)

24. In a large company engaged in the sale of consumer products, physical distribution of finished products to warehouses and down to the retailers is an important aspect from the point of view of cost of distribution and efficient customer service. Discuss a procedure for cost control in evolving a strategy for efficient distribution of goods.

(I. C. W. A., Final)

25. Investment of men, money and materials in various Research and Development Projects both in the public and private sectors in India is on the increase. The urge to invest more in this area has been accelerated because of the increasing tax incentives offered by the Government. Suggest a method for controlling the expenditure on R & D and measuring its efficiency.

(I. C. W. A., Final)

CHAPTER 6

ACCOUNTING SYSTEMS FOR RECORDING COSTS

Cost Ledger Accounting. Cost accounting follows the fundamental principles of double entry bookkeeping. As in the case of general accounting system, transactions relating to factory operations which are ultimately reflected in the cost accounts are recorded in the books of original entry. Summaries from these books are journalised and posted in the general ledger which contains control accounts and subsidiary books. Instead of being posted in the general ledger, cost transactions may be recorded in a separate Cost Ledger or Factory Ledger. Similarly, there may be one general journal to summarise all original entries or separate journals may be kept to record labour, material, and overhead transactions.

As the number and types of transactions involved in accounting are numerous, a number of individuals are employed in their recording and analysis. Hence in order to facilitate handling the transactions, instead of being posted in the general ledger, are recorded in a subsidiary ledger. Transactions kept in details in one or more accounts of the subsidiary ledger are posted in totals, at the end of a period, to the control accounts. Thus, the balance in a control account represents the totals contained in a number of accounts of similar nature in a subsidiary ledger. For example, the balance in the Work-in-Progress Control Account represents, in aggregate, the balances of the respective Job Accounts. (An account is maintained for each job.) More often, the accounts in the subsidiary ledger are dispensed with and postings are made to the control accounts from detailed information kept in subsidiary records. The main control accounts and their functions are summarised below :

Stores Control Account or Stores Ledger Control Account

Deals with materials transactions : Receipts are posted from goods received notes (or receipt vouchers) and issues from materials requisitions or materials issue analysis sheet. The account also records issues of materials to outside parties, returns through return notes, and stores (inventory) adjustments. The balance of this account represents the total balance of stock which should agree with the aggregate of the balances of individual folios in the stores ledger. (Materials purchased for a specific job are generally debited to the Work-in-Progress Control Account and not to the Stores Ledger Control Account.)

Wages Control Account

Records labour transactions : Postings are made from wages analysis sheet. The amount is debited with the gross wages and is cleared by the transfer of direct labour to Work-in-Progress, and indirect labour to Factory, Administration and Selling and Distribution Overhead Control or Research and Development or Capital Account, as the case may be.

Factory Overhead Control Account

Deals with manufacturing overhead expenses : To this account is debited the amount of indirect material, indirect labour, and indirect expenses incurred. The figures are obtained from materials issue analysis sheet, wages analysis sheet, and Standing Order Numbers or Cost

Accounting Numbers summary (discussed in the chapters dealing with overhead) The account is credited with the amount of overhead recovered, as obtained from the applied overhead analysis sheet. Where separate Overhead Applied Account is opened, credit is given to this account

Work-in-Progress Control Account

The account is debited with the opening balance of work-in-progress, and material, labour and factory overhead costs (recovered) and is credited with the cost of finished goods

Finished Goods Control Account

The account is debited with the opening balance of finished goods, the cost of finished goods for the period transferred from the Work-in-Progress Control Account and the amount of administration overhead recovered, if administration overhead is not treated as period cost. It is credited with the cost of sales (by transfer to Cost of Sales Account). The balance of the account after writing back the unrecovered administration overhead, represents unsold stock carried over.

Administration Overhead Account

Administration overhead cost is debited to this account, the amount of overhead recovered in the finished goods sold is credited. Another method is to close the Administration Overhead Account by transfer to Costing Profit and Loss Account. In this case, no amount of administration cost is charged to the Finished Goods Account. When administration overhead is prorated to manufacturing and selling and distribution overheads, the Administration Overhead Account is credited with the amount so transferred.

Cost of Sales Account

This account is debited with the cost of goods sold and selling and distribution overhead recovered, and is closed by transfer to Costing Profit and Loss Account.

Selling and Distribution Overhead Account

Selling and distribution costs are debited to the Selling and Distribution Overhead Account. At the end of the period, the account is closed by transfer to Cost of Sales Account.

Overhead Adjustment Account

The amount of under- or over-absorbed factory, administration, selling and distribution overheads is debited or credited to this account. The balance at the end of a period, if not carried over to the next period, is transferred to Costing Profit and Loss Account or prorated to Cost of Sales Account, Work-in-Progress Account and Finished Stock Account. Sometimes this account is not maintained and the amount of under- or over-absorption is transferred direct to Costing Profit and Loss Account. If the under- or over-absorption is carried over to the next accounting period, the amount is credited to Overhead Suspense Account by debit to Overhead Adjustment Account.

Costing Profit and Loss Account

This account records the transfer of the amounts of under- and over-absorbed overhead, the sale value of goods sold, and the balance from the Cost of Sales Account. Abnormal losses or gains to be kept out of costs are also debited or credited to this account. The closing balance of this account represents the costing profit or loss which should be reconciled with the financial profit or loss.

Cost Ledger Control Account

The function of this account which is often referred to as General Ledger Adjustment Account, is discussed in the following paragraph.

In the cost ledger accounting system, the cost control accounts mentioned above are kept separate from the financial ledgers that record all financial transactions. No personal accounts are maintained in the cost books but on the principles of double entry, all such transactions are contra debited or credited to the Cost Ledger Control Account maintained for the purpose. The Cost Ledger Control Account makes the cost ledger self-balancing. In fact, this account is equivalent

to the Personal, or Cash or Bank Accounts, as the case may be, in the financial books. Financial transactions such as those on account of material purchases, miscellaneous expenses, and wages and salaries of workers and staff are credited to the Cost Ledger Control Account by contra debit to the various control accounts. Similarly, all sales are debited to the Cost Ledger Control Account. Transfer from financial books to cost books, such as of departmental capital work is made through this account. Purely cost accounting transactions involving no finances, e.g. transfer of manufacturing overhead cost to Work-in-Progress Control Account and transfer of finished goods from Work-in-Progress Control Account to Finished Goods Control Account do not pass through the Cost Ledger Control Account because double entries in respect of these transactions are already complete without the Cost Ledger Control Account.

The principles of Cost Ledger accounting are illustrated below :

Data assumed :

(a) Closing balance at the end of the previous accounting period

	Dr	Cr
Stores Control Account	Rs. 2,000	
Work-in-Progress Control Account	Rs. 6,000	
Finished Goods Control Account	Rs. 8,000	
Cost Ledger Control Account	-	Rs. 16,000

(b) Financial transactions during the accounting period .

Stores purchases	
For stock	Rs. 38,000
For special jobs	Rs. 2,000
Wages and salaries	
Factory	Rs. 40,000
Office	Rs. 4,000
Sales office	Rs. 6,000
Goods sold (sales)	Rs. 2,00,000
Other expenses	Rs. 80,000

(c) Cost transactions and cost analysis during the period .

Materials issue analysis	
Direct materials	Rs. 20,000
Indirect materials (Fy.)	Rs. 10,000
Wages analysis	
Direct labour	Rs. 30,000
Indirect labour (Fy.)	Rs. 10,000

Overhead incurred and recovered .

	Incurred	Recovered
Manufacturing	Rs. 50,000	Rs. 65,000
Administration	Rs. 10,000	Rs. 13,500
Selling and Distribution	Rs. 20,000	Rs. 27,000
Goods finished, at cost	Rs. 1,20,000	
Cost of goods sold	Rs. 1,38,000	

Journal entries for the above transactions will be as follows :—

Dr. Stores Control Account	Rs. 38,000	
Dr. Work-in-Progress Control Account	Rs. 2,000	
Cr. Cost Ledger Control Account		Rs. 40,000
(To record materials purchased)		
Dr. Work-in-Progress Control Account	Rs. 20,000	
Dr. Factory Overhead Control Account	Rs. 10,000	
Cr. Stores Control Account		Rs. 30,000
(To record issues of direct and indirect materials)		

Dr. Wages Control Account	Rs. 50,000	
Cr. Cost Ledger Control Account		Rs. 50,000
(Wages and salaries for the period)		

Dr. Work-in-Progress Control Account	Rs. 30,000	
Dr. Factory Overhead Control Account	Rs. 10,000	
Dr. Administration Overhead Account	Rs. 4,000	
Dr. Selling and Distribution Overhead Account	Rs. 6,000	
Cr. Wages Control Account		Rs. 50,000

(To record direct and indirect labour, and salaries booked to administration, selling and distribution)

Dr. Factory Overhead Control Account	Rs. 50,000	
Dr. Administration Overhead Account	Rs. 10,000	
Dr. Selling and Distribution Overhead Account	Rs. 20,000	
Cr. Cost Ledger Control Account		Rs. 80,000
(To record overhead expenses incurred)		

Dr. Work-in-Progress Control Account	Rs. 65,000	
Cr. Costing Profit and Loss Account	Rs. 5,000	
Cr. Factory Overhead Control Account		Rs. 70,000

(Factory Overhead recovered ; unrecovered amount charged to Costing Profit and Loss Account)

Dr. Finished Goods Control Account	Rs. 13,500	
Dr. Costing Profit and Loss Account	Rs. 500	
Cr. Administration Overhead Account		Rs. 14,000

(Administration Overhead recovered ; under-recovery charged to Costing Profit and Loss Account)

Dr. Cost of Sales Account	Rs. 27,000	
Cr. Costing Profit and Loss Account		Rs. 1,000
Cr. Selling and Distribution Overhead Account		Rs. 26,000
(Selling and distribution overhead recovered ; over-absorption credited to Costing Profit and Loss Account)		

(Note : Instead of transferring the under- and over-absorbed overhead direct to Costing Profit and Loss Account, they may be passed through a subsidiary account known as Overhead Adjustment Account.)

Dr. Finished Goods Control Account	Rs. 1,20,000	
Cr. Work-in-Progress Control Account		Rs. 1,20,000
(To transfer cost of production of finished goods)		

Dr. Cost of Sales Account	Rs. 1,38,000	
Cr. Finished Goods Control Account		Rs. 1,38,000
Dr. Costing Profit and Loss Account	Rs. 1,65,000	
Cr. Cost of Sales Account		Rs. 1,65,000
(To record cost of goods sold)		

Dr. Cost Ledger Control Account	Rs. 2,00,000	
Cr. Costing Profit and Loss Account		Rs. 2,00,000
(To record sale of goods ; sales value)		

Dr. Costing Profit and Loss Account	Rs. 30,500	
Cr. Cost Ledger Control account		Rs. 30,500

The individual Control Accounts are shown below :

STORES CONTROL ACCOUNT

Balance (b/f)	Rs. 2,000	Work-in-Progress Control	
Cost Ledger Control Account (a)	Rs. 38,000	Account (d)	Rs. 20,000
		Fy. Overhead Control Account (e)	Rs. 10,000
		Balance (c/f)	Rs. 10,000
	<u>Rs. 40,000</u>		<u>Rs. 40,000</u>

WAGES CONTROL ACCOUNT

Cost Ledger Control Account (c)	Rs. 50,000	Work-in-Progress Account (f)	Rs. 30,000
		Fy. Overhead Control Account (g)	Rs. 10,000
		Admn. Overhead Account (h)	Rs. 4,000
		Selling & Distribution Overhead	
		Account (i)	Rs. 6,000
	<u>Rs. 50,000</u>		<u>Rs. 50,000</u>

FACTORY OVERHEAD CONTROL ACCOUNT

Cost Ledger Control Account (j)	Rs. 50,000	Work-in-Progress Account (m)	Rs. 65,000
Stores Control Account (c)	Rs. 10,000	Costing Profit & Loss Account (n)	Rs. 5,000
Wages Control Account (g)	Rs. 10,000		
	<u>Rs. 70,000</u>		<u>Rs. 70,000</u>

ADMINISTRATION OVERHEAD ACCOUNT

Cost Ledger Control Account (k)	Rs. 10,000	Finished Goods Control Account (q)	Rs. 13,500
Wages Control Account (h)	Rs. 4,000	Costing Profit & Loss Account (r)	Rs. 500
	<u>Rs. 14,000</u>		<u>Rs. 14,000</u>

SELLING AND DISTRIBUTION OVERHEAD ACCOUNT

Cost Ledger Control Account (l)	Rs. 20,000	Cost of Sales Account (o)	Rs. 27,000
Wages Control Account (i)	Rs. 6,000		
Costing Profit & Loss Account (p)	Rs. 1,000		
	<u>Rs. 27,000</u>		<u>Rs. 27,000</u>

WORK-IN-PROGRESS CONTROL ACCOUNT

Balance (b/f)*	Rs 6,000	Finished Goods Control Account (s)	Rs 1,20,000
Cost Ledger Control Account (b)	Rs 2,000	Balance (c/f)*	Rs 3,000
Stores Control Account (d)	Rs 20,000		
Wages Control Account (f)	Rs 30,000		
Fy. Overhead Control Account (m)	Rs 65,000		
	Rs 1,23,000		Rs 1,23,000

*These represent the opening and closing balances of cost of incomplete goods

FINISHED GOODS CONTROL ACCOUNT

Balance (b/f)	Rs 8,000	Cost of Sales Account (t)	Rs 1,38,000
Work-in-Progress Account (s)	Rs 1,20,000	Balance (c/f)	Rs 3,500
Admn. Overhead Account (r)	Rs 13,500		
	Rs 1,41,500		Rs 1,41,500

COST OF SALES ACCOUNT

Finished Goods Control Account (t)	Rs 1,38,000	Costing Profit & Loss Account (u)	Rs 1,65,000
Selling and Distribution Overhead Account (n)	Rs 27,000		
	Rs 1,65,000		Rs 1,65,000

COSTING PROFIT AND LOSS ACCOUNT

Cost of Sales Account (u)	Rs 1,65,000	Selling & Distribution Overhead Account (p)	Rs 1,000
Fy. Overhead Account (n)	Rs 5,000	Cost Ledger Control Account (sales) (v)	Rs 2,00,000
Administration Overhead Account (r)	Rs 500		
Cost Ledger Control Account (w) (costing profit)	Rs 30,500		
	Rs 2,01,000		Rs 2,01,000

COST LEDGER CONTROL ACCOUNT

Costing Profit & Loss Account (v)	Rs 2,00,000	Balance (b/f)	Rs 16,000
Balance (c/f)	Rs 16,500	Stores Control Account (a)	Rs 38,000
		Work-in-Progress Control	
		Account (b)	Rs 2,000
		Wages Control Account (c)	Rs 50,000
		By Overhead Control Account (j)	Rs 50,000
		Administration Overhead	
		Account (k)	Rs 10,000
		Selling and Distribution Overhead	
		Account (l)	Rs 20,000
		Costing Profit & Loss Account (w)	Rs 30,500
	<u>Rs 2,16,500</u>		<u>Rs 2,16,500</u>

losing balance (c/f)

	Dr	Cr
	Rs	Rs
Work-in-Progress	3,000	
Stores	10,000	
Finished Goods	3,500	
Cost Ledger Control Account		16,500
	<u>Rs 16,500</u>	<u>Rs 16,500</u>

Another example of Cost Ledger accounting is given below

EXAMPLE 61

Details are given below of the operations during a period of six months of a manufacturing company which makes one standard product. Using the information given you are required to

- show the factory expense control account, administration overhead control account and selling and distribution overhead accounts,
- prepare a statement to show what profit will appear in the cost account,
- prepare a statement to show what profit will appear in the financial accounts

Data for a period of six months

	Opening Stock		Closing Stock	
	Units	Rs	Units	Rs
Raw materials				
Direct		15,000		20,000
Indirect production		1,700		3,000
Work-in-Progress				
Direct materials		3,000		3,500
Direct wages		1,000		1,200
Factory expenses		600		800
Finished stock	7,500	9,000	10,000	12,000

	Rs.
Sales, (1,50,000 units)	2,25,000
Rent of offices	1,500
Advertising	2,000
Stationery	840
Rates on factory	2,700
Salesmen's commission and expenses	1,400
Insurance of offices	80
Depreciation of machinery	6,400
Warehouse rentals	800
Repairs to plant	1,850
Secretarial wages	3,000
Salesmen's salaries	6,000
Insurance of factory	1,100
Accounting staff wages	8,200
Delivery charges	450
Other factory expenses	7,950
Other administration expenses	2,480
Other sales and distribution expenses	6,250
Purchase of materials Direct	65,000
Indirect production	5,000
Direct wages	55,000
Factory indirect wages	15,000
Loan interest received	500
Included in the factory expenses are	
Notional charge for use of own premises	2,800
Notional interest on capital employed in the business	400

"Other sales and distribution expenses" wrongly contain an amount of Rs. 1,500 which should be in "other factory expenses."

The cost accounts are kept separate from the financial accounts. In the cost accounts, the company absorbs factory expenses at 40% of prime cost of finished units produced, administration overhead at Rs. 0.10 per unit produced and selling and distribution overhead at Rs. 0.09 per unit delivered. (I.C.M.A. Part II adapted)

ANSWER .

(a) <i>Factory Expenses Control</i>			
	Rs.		Rs.
Opening work-in-progress	600	Finished Goods Stock Control	
Rates on factory	2,700	—Fv overhead absorption	45,720
Depreciation of machinery	6,400	Closing work-in-progress	800
Repairs to plant	1,850		
Insurance of factory	1,100		
Indirect materials			
	1,700		
	(+) 5,000		
	(-) 3,000		
	<hr/>		
	3,700		
Indirect wages	15,000		
Other factory expenses			
	7,950		
	(+) 4,500		
	<hr/>		
	12,450		
Overhead adjustment, over-absorption (Balancing entry)	2,720		
	<hr/>		
	46,520		
	<hr/>		
			<hr/>
			46,520
			<hr/>

Factory expenses absorbed are calculated as follows :

	Rs.	
Opening work-in-progress		
Direct material	3,000	
Direct wages	1,000	
	<hr/>	4,000
Add : Direct materials		
	15,000	
	(+) 65,000	
	(-) 20,000	
	<hr/>	60,000
Add Direct wages	55,000	
Less Closing work-in-progress		
Direct material	3,500	
Direct wages	1,200	50,300
	<hr/>	<hr/>
		1,14,300
Prime cost of Finished Goods		
Factory Expenses absorbed		
(40% of Rs. 1,14,300)		45,720

Administration Overhead Control

	Rs.		Rs.
Rent of offices	1,500	Finished Goods Stock Control	
Stationery	840	absorption of admin overheads	15,250
Insurance of offices	80	Overhead adjustment	
Secretarial wages	3,000	-under absorption (Balancing entry)	850
Accounting Staff wages	8,200		
Other administration expenses	2,480		
	<hr/>		<hr/>
	16,100		16,100
	<hr/>		<hr/>

(a) Units produced Sales closing stock opening stock 1,50,000 - 10,000 7,500 1,52,500
 Administration overhead absorbed 1,52,500 Re. 0.10 Rs. 15,250

Selling and Distribution Overhead Control

	Rs.		Rs.
Advertising	2,000	Cost of sales	
Salesmen's commission and expenses	1,400	-- absorption of Selling and	
Warehouse rentals	800	Distribution overhead	
Salesmen's salaries	6,000	(1,50,000 units sold Re. 0.09)	13,500
Delivery charges	450		
Other sales and distribution expenses			
	Rs.		
	6,150		
	(-) 4,500	1,750	
Overhead adjustment, over-			
absorption (Balancing entry)	1,100		
	<hr/>		<hr/>
	13,500		13,500
	<hr/>		<hr/>

(b) Cost of Sales :	Rs.	Rs.
Opening balance	9,000	
Prime cost	1,14,300	
Fy. overhead	45,720	
Admn. Overhead	15,250	
Less Closing balance	12,000	
	---	1,72,270
Add Selling and Distribution overhead		11,500
Add Administration Overhead under-absorbed		850
Deduct Factory overhead over-absorbed		2,720
Deduct Selling and Distribution overhead over-absorbed		1,100

		1,82,800
Sales Value		2,25,000

Profit as per Costing Profit and Loss Account		12,200
	Rs.	
(c) Profit as per Cost Accounts	42,200	
Add Loan interest received	500	
Deduct Notional rent	2,800	
Deduct Notional interest	400	

Profit as per Financial Accounts	39,500	

Reconciliation of Cost Accounts with Financial Accounts. There are certain transactions which are naturally included in the financial accounts as they relate to items of actual expenditure but they do not find a place in the cost accounts. Similarly, there are a few items of costs which are mere adjustments or notional costs involving no financial outlay ; these are not included in financial accounts.

- (a) *Transactions of a purely financial nature* (both charges and receipts), which are included in financial accounts but not in cost accounts are :

Charges

- Loss on sale or exchange of capital assets
- Expenses such as stamp duty, discount, etc. in connection with raising and transfer of capital (transfer and issue of shares, debenture etc.)
- Loss on investments
- Interest on bank loans and mortgages
- Fines and penalties.

Receipts

- Profit on sale of stores.
- Receipts on issues and transfers of capital, e.g. fees received on issue and transfer of shares etc.
- Receipts on investments (interest received on bank deposits and loans)
- Rent receivable
- Dividends received.

- (b) *Abnormal items of expenditure and income which, if included in cost of production, would vitiate costs* : Such expenses, which appear in financial accounts as well as cost accounts, are : excessive or avoidable rejections, defective work and spoilage, heavy losses of stores, losses due to theft, pilferage, or acts of nature, abnormal idle time, unexpected heavy income in the nature of windfalls, abnormal gain etc.
- (c) *Appropriations of profit which are not included in cost accounts* : Payment of income tax and dividends, transfers to reserves, heavy donations and charities, and write off of goodwill, preliminary expenditure, and patents. However, these transactions appear only in Profit and Loss Appropriation Account and the financial Profit and Loss Account is not affected.
- (d) *Items of controversial nature* : There are certain items regarding which there is difference of opinion amongst accountants as to whether or not these should be charged to cost accounts. These items which include interest on capital, rent on buildings owned, and taxes and sometimes, administration overhead in which are discussed in Chapter 5. If such items are included in costs, costing and financial profits will differ.
- (e) *Difference arising due to other reasons* :
 - (i) The rates and methods of charging depreciation may be different in the two sets of accounts. For instance, the diminishing balance method may be adopted in the financial accounts as per the Income Tax rules, but in the cos. accounts, one of the methods based on technical requirements or usage, e.g. production hours or production units may be in use.
 - (ii) Values of stocks of materials, components, finished goods, and work-in-progress as per the financial accounts may not agree with those taken in the cost accounts. In financial accounts, valuation of stocks is made normally on the basis of market value or cost, whichever is lower. In cost accounts, stock is valued in accordance with the method of accounting in use, e.g. Lifo, Fifo, average rate, etc. The stock may, therefore, be at average or replacement cost, arginal cost, or standard or historical cost.
 - (iii) In the method of absorption of overhead at pre-determined rates, there arises a difference between the actual expenses and the pre-determined amount charged to cost accounts. In the financial acc:unts, the amount incurred only is taken into account.
 - (iv) Some concerns adopt the method of charging direct wages to costs of products at pre-determined rates. This results in a difference between the pre-determined amount charged to cost accounts and the actual wages booked in the financial accounts.

It will be seen that the cost ledger accounting system differs from the financial accounts in many respects. In the former, the stress is on the objective form of accounting and the transactions are analysed and recorded according to the purpose they serve, while the financial accounts are maintained in a subjective form according to the nature of the expenditure. Another major point of dissimilarity between the cost and financial ledgers is that many of the accounts in the financial ledger such as Personal Accounts, Capital Assets Accounts, and Appropriation Accounts, do not find place in the cost ledger.

In view of the differences mentioned in the preceding paragraphs, the results obtained from the cost and financial accounts differ. The cost accountant furnishes various data to assist the management in decision making. It is essential that such data should be correct. For this reason and also in order to prove the correctness of the figures posted in the two sets of accounts, there is a need to reconcile the figures as shown in the cost ledger with those shown in the financial accounts. Such a reconciliation is done at regular intervals; the figure of profit either as per the cost ledger or as per the financial ledger is taken as the starting point of the reconciliation. For example, if the profit shown in the cost ledger is taken first and the amounts that give rise to differences are added or subtracted from it, the resultant figure should agree with the profit as shown in the financial ledger.

Sometimes, certain items like abnormal expenditure not charged to costs, notional items included in costs, and under- and over-absorbed overhead are finally transferred to the Costing Profit and Loss Account if not carried forward to the subsequent period. If so, there will be no difference on these accounts between the 'costing profit' and the 'financial profit' and no further adjustment will be required at the time of reconciling the profits shown in the two sets of accounts. While carrying out the reconciliation, therefore, care should be exercised to see whether or not the 'costing profit' is inclusive of these adjustments.

A few examples illustrating the method of reconciliation between cost and financial accounts are given below :

EXAMPLE 6.2.

From the following particulars, prepare (a) a statement of cost of manufacture for the year, (b) a statement of profit as per cost accounts and (c) profit and loss account in the financial books and a reconciliation of the difference in the profits as shown by (b) and (c) above :—

	Rs.
Opening stock of raw materials	1,00,000
Closing stock of raw materials	1,50,000
Opening stock of finished product	2,00,000
Closing stock of finished product	50,000
Purchase of raw materials	6,00,000
Wages	2,50,000

Calculate factory overhead at 25 per cent on prime cost. Office overhead will be levied at 75 per cent on factory overhead. Actual works expenditure amounted to Rs. 1,93,750 and actual office expenses amounted to Rs. 1,52,500. The selling price was fixed at 25 per cent above cost price.
(I. C. W. A., Inter)

ANSWER :

<i>Cost of manufacture</i>	Rs.	Rs.
(a) Raw materials	1,00,000	
	+ 6,00,000	
	(—) 1,50,000	
	<hr/>	5,50,000
Wages		2,50,000
Factory overhead (25% on Prime cost)		2,00,000
Office overhead (75% on Fy. overhead)		1,50,000
		<hr/>
Cost of manufacture		Rs. 11,50,000

Statement of Profit (Cost Accounts)

	Rs.
(b) Opening Stock	2,00,000
Cost of manufacture	11,50,000
Less Closing Stock	50,000
	<hr/>
Cost of Sales	13,00,000
Profit (25% of cost)	3,25,000
	<hr/>
Sales	16,25,000

Profit and Loss Account

	Rs.	Rs.		Rs.
(c) To Opening Stock		2,00,000	By Sales	16,25,000
„ Raw materials			„ Closing Stock	50,000
„ Opening Stock	1,00,000			
„ Purchase	6,00,000			
Less Closing Stock	1,50,000	5,50,000		
„ Wages		2,50,000		
„ Factory overhead		1,93,750		
„ Office overhead		1,52,500		
„ Profit		3,28,750		
		<hr/>		<hr/>
		16,75,000		16,75,000
		<hr/>		<hr/>

Reconciliation Statement

	Rs.	Rs.
(d) Profit as per Cost Accounts		3,25,000
Add Over-absorption of		
Fy. overhead	2,00,000	
	(—) 1,93,750	
	<hr/>	6,250
Less under-absorption of		
office overhead	1,52,500	
	(—) 1,50,000	
	<hr/>	(—) 2,500
		<hr/>
Profit as per Financial Accounts		3,28,750

EXAMPLE 6.3.

A company's net profit as per the cost books was Rs. 23,063 whereas the audited final accounts showed a profit of Rs. 16,624. With the help of the following data you are required to prepare a reconciliation statement, and explain the reasons for the difference between the two figures.

Profit and Loss Account
Year ended 31st March, 19××

	Rs.	Rs.		Rs.
Opening Stock	2,47,179		Sales	3,46,500
Purchase	82,154			
	<u>3,29,333</u>			
Closing Stock	75,121			
	<u>2,54,212</u>			
Direct wages		23,133		
Factory overhead		20,826		
Gross profit c/d		<u>48,329</u>		
	Total Rs. 3,46,500		Total Rs. 3,46,500	
Administration expenses		9,845	Gross Profit b/f	48,329
Selling expenses		22,176	Miscellaneous income	316
Net Profit		<u>16,624</u>		
	Total Rs. 48,645		Total Rs. 48,645	

The costing records show :

- (a) Stock balance of Rs. 78,197
- (b) Direct wages absorbed during the year—Rs. 24,867
- (c) Factory overhead absorbed—Rs. 19,714
- (d) Administration expenses charged @ 3 per cent of selling prices.
- (e) Selling expenses charged @ 5 per cent of value of sales.
- (f) No mention of miscellaneous income.

(J. C. W. A., Inter)

ANSWER:

	Rs.	Rs.
<i>Profit as per Cost Accounts</i>		24,061
Less : Difference in valuation of closing stock	78,197	
	<u>75,121</u>	
		(-) 3,076
Factory overhead under-absorbed	20,826	
	<u>19,714</u>	
		(--) 1,112
Selling expenses under-absorbed	22,176	
	<u>17,325</u>	
		(--) 4,851
Add : Wages over-absorbed	24,867	
	<u>23,133</u>	
		1,734
Administration overhead over-absorbed	10,395	
	<u>9,845</u>	
		550
Sundry income not shown in Costing Profit		<u>316</u>
		16,624

Profit as per Financial Accounts

EXAMPLE 6.4.

NIA Limited operates on a non-integrated accounting system. At the end of April, the financial accountant has produced the final accounts, shown below. Based on these accounts and data supplied by the cost accountant, a reconciliation statement has been prepared, also as shown below :

You are required to prepare the following accounts as they would appear in the cost ledger :

- (i) raw material stores ;
- (ii) work-in-progress ;
- (iii) finished goods ;
- (iv) cost of sales

ANSWER :

Cost ledger accounts are as follows :—

(i) <i>Raw material stores account</i>			
	Rs.		Rs.
Opening stock (b/d) (60,500 + 1,100)	61,600	Closing stock (c/d) (65,000 + 750)	65,750
Purchases	3,20,000	Work-in-progress a/c	3,15,850
	<u>3,81,000</u>		<u>3,81,600</u>
Balance (b/d)	65,750		
(ii) <i>Work-in-progress account</i>			
Opening stock (b/d) (36,700 – 900)	35,800	Closing stock (c/d) (35,200 – 500)	34,700
Raw material stores a/c	3,15,850	Finished goods a/c	6,03,950
Direct wages	1,25,000		
Production overhead (1,60,000 + 2,000)	1,62,000		
	<u>6,38,650</u>		<u>6,38,650</u>
Balance (b/d)	34,700		
(iii) <i>Finished goods account</i>			
Opening stock (b/d) (45,600 – 1,300)	44,300	Closing stock (c/d) (47,600 + 500)	48,100
Work-in-progress a/c	6,03,950	Cost of sales a/c	4,00,150
	<u>6,48,250</u>		<u>6,48,250</u>
Balance (b/d)	48,100		
(iv) <i>Cost of sales account</i>			
Finished goods a/c	6,00,150	Sales	10,00,000
Administration expenses	1,10,000		
Selling and distribution expenses	1,50,000		
Costing profit/loss account	1,39,850		
	<u>10,00,000</u>		<u>10,00,000</u>

Integral Accounting. The modern trend is to do away with the maintenance of separate sets of books for cost accounting and most companies now use the integral or integrated accounting system (maintenance of accounts in integral form) that records all financial and cost accounting transactions in one combined ledger.

The *advantages* of integral accounting are as follows :—

- (i) The need for separate sets of financial and cost accounts ledgers does not exist and the necessity for reconciliation between the two, as is done in the case of cost ledger control accounting, is obviated. This saves clerical expenditure.
- (ii) There is an automatic check on the correctness of the cost data. This ensures that all legitimate expenditure is included in cost accounts. Reliable and proved cost data create confidence in the management.
- (iii) Fewer accounts and records are required, and duplication in accounting and analysis is avoided.

- (iv) As cost accounts are posted straight from the books of original entry, there is no delay in obtaining cost data.
- (v) Integral system offers an additional advantage from the psychological point of view. It shows the complementary status of cost and financial accounting which need not be considered as two separate watertight compartments.
- (vi) Centralised accounting, which is possible in the integrated system, results in economy.
- (vii) The knowledge of financial accounting and cost accounting may be pooled together.
- (viii) Integrated accounting widens the outlook of the accountant and his staff who are placed in a better position to appreciate the entire accounting system.
- (ix) In integral accounting, there is no need to open a Cost Ledger Control Account because it is possible to post each transaction on double entry basis without the necessity for opening a balancing account.

The essential features of an integrated system are as follows :—

- (i) The integrated system records, besides internal costing transactions, other financial items not normally required for cost accounting. Accounts for capital expenditure, sundry creditors and debtors, share capital, cash and bank transactions, and pre-payments and accruals are opened.
- (ii) Store transactions are recorded in the Stores Control Account. The cost of stores purchased is debited to the Stores Control Account and credit is given to Cash Account or Sundry Creditors Account depending upon whether the purchase is made for cash or credit.
- (iii) The wages paid are debited to the Wages Control Account ; contra credit is taken in the Cash or Bank Account. Similarly, overhead expenses incurred are debited to the Overhead Control Account by credit to the Cash or Bank Account or the Sundry Creditors Account.
- (iv) Suitable cost analysis is made of the transactions relating to material, labour and overhead, which are posted in the Stores, Wages, and Overhead Control Accounts and at the end of the accounting period, transfer of the total is made to the Work-in-Progress Account by crediting the various control accounts. The day-to-day cost analysis made for this purpose is known as 'making third entries'. As would be apparent, the third entries do not mean entries in the same sense as the entry of transactions in ledgers but these are simply a sort of cost analysis.
- (v) All accruals are debited and advance payments credited to the respective control accounts by contra entries in the accrual and prepayment accounts.
- (vi) Capital expenditure is separated in the process of cost analysis and credited to the control accounts by debit to the Capital Assets Account.

- (vii) Sometimes a separate 'Cost Control Account' is opened to record the cost transactions. The Wages Control and Overhead Control Accounts are dispensed with and all transactions relating to wages and overhead are entered in the Cost Control Account. Materials issued to production are debited to the Cost Control Account by credit to the Stores Control Account. If a Provision for Depreciation Account is maintained, depreciation is credited to this account by debit to the Cost Control Account. At the end of the accounting period, 'third entries' are made and the totals are posted to the Work-in-Progress Account by credit to the Cost Control Account.
- (viii) The Work-in-progress Account may be split up into three separate accounts, viz. Materials-in-Process, Labour-in-Process, and Factory Overhead-in-Process Accounts.

The procedure for integrated accounting is illustrated below.

EXAMPLE 6.5.

As at 31st December, 19×1, the following balances appeared in the nominal ledger of a company operating an integrated accounting system :

	Rs '000
10 Fixed Assets	100
11. Capital and reserves	310
12 Work-in-Progress :	
Materials in store & process	75
Direct wages in process standard	25
Factory overhead in process	15
13 Finished stock	83
14. Trade debtors	96
15. Cash at bank	24
16. Trade creditors	60
17. Sales	525
18. Standard factory cost of sales	475
19 Materials price variance (debit)	17
20. Direct wages variance (credit)	3
21. Factory overhead variance (credit)	12

During December 19×1, the following transactions took place .

Sales (on credit)	46
Cash received from debtors	37
Cash paid : to creditors	21
direct wages	22
indirect wages	8
Materials bought on credit (standard cost Rs. 45)	47
Factory overheads incurred—on credit	13
Output (at standard cost) :	
Materials	46
Direct wages	24
Factory overhead	14
—	84
Standard cost of sales	41
Closing valuations :	
Direct wages in process (at standard)	24
Factory overhead in process (at standard)	20

You are required to write up and close off the active accounts.

(I. C. M. A., Inter—Adapted)

ANSWER :

10. FIXED ASSETS

<i>1st Dec. × 1</i>		<i>31st Dec. × 1</i>	
Balance (b/f)	Rs. 1,00,000	Balance (c/f)	Rs. 1,00,000

11 CAPITAL AND RESERVES

<i>31st Dec. × 1</i>		<i>1st Dec. × 1</i>	
Balance (c/f)	Rs. 3,10,000	Balance (b/f)	Rs. 3,10,000

12 WORK-IN-PROGRESS (AT STANDARD)

<i>1st Dec. × 1</i>	Rs.	<i>31st Dec. × 1</i>	Rs.	Rs.
Balance (b/f)		Finished Stock		
Materials	75,000	Materials	40,000	
Direct wages	25,000	Direct wages	24,000	
Fy. overhead	15,000	Fy. overhead	14,000	
	Rs. 1,15,000			Rs. 84,000
Control Accounts transfers		Balance (c/f)		
Materials	45,000	Materials	74,000	
Direct wages	23,000	Direct wages	24,000	
Fy. overhead	19,000	Fy. overhead	20,000	
				Rs. 1,18,000
	Rs. 2,02,000			Rs. 2,02,000

<i>1st Jan. × 2</i>	
Balance (b/f)	
Materials	74,000
Direct wages	24,000
Fy. overhead	20,000
	Rs. 1,18,000

MATERIALS CONTROL

<i>31st Dec. × 1</i>	Rs.	<i>31st Dec. × 1</i>	Rs.
Sundry Creditors	47,000	Work-in-Progress	45,000
		Materials Price Variance	2,000
	Rs. 47,000		Rs. 47,000

19. MATERIALS PRICE VARIANCE

<i>1st Dec. × 1</i>	Rs.	<i>31st Dec. × 1</i>	Rs.
Balance (b/f)	17,000	Balance (c/f)	19,000
Materials Control	2,000		
	Rs. 19,000		Rs. 19,000

DIRECT WAGES CONTROL

<i>31st Dec. × 1</i>		<i>31st Dec × 1</i>	
	Rs.		Rs.
Cash	22,000	Work-in-Progress	23,000
Direct Wages Variance	1,000		
	<u>Rs. 23,000</u>		<u>Rs. 23,000</u>

20. DIRECT WAGES VARIANCE

<i>31st Dec. × 1</i>		<i>1st Dec × 1</i>	
	Rs.		Rs.
Balance (c/f)	4,000	Balance (b/f)	3,000
		Direct Wages Control	1,000
	<u>Rs. 4,000</u>		<u>Rs. 4,000</u>

FACTORY OVERHEAD CONTROL

<i>31st Dec × 1</i>		<i>31st Dec. × 1</i>	
	Rs.		Rs.
Cash	8,000	Work-in-Progress	19,000
Sundry Creditors	13,000	Fy Overhead Variance	2,000
	<u>Rs. 21,000</u>		<u>Rs. 21,000</u>

21. FACTORY OVERHEAD VARIANCE

<i>31st Dec. × 1</i>		<i>1st Dec. × 1</i>	
	Rs.		Rs.
Fy. Overhead Control	2,000	Balance (b/f)	12,000
Balance (c/f)	10,000		
	<u>Rs. 12,000</u>		<u>Rs. 12,000</u>

13. FINISHED STOCK

<i>1st Dec. × 1</i>		<i>31st Dec × 1</i>	
	Rs.		Rs.
Balance (b/f)	96,000	Cash	37,000
31st Dec. '× 2		Balance (c/f)	1,05,000
Sales	46,000		
	<u>Rs. 1,42,000</u>		<u>Rs. 1,42,000</u>

15. CASH AT BANK

<i>1st Dec. × 1</i>		<i>31st Dec. × 1</i>	
	Rs.		Rs.
Balance (b/f)	24,000	Sundry Creditors	21,000
Sundry Debtors	37,000	Direct wages	22,000
		Indirect wages	8,000
		Balance (c/f)	10,000
	<u>Rs. 61,000</u>		<u>Rs. 61,000</u>

16. SUNDRY CREDITORS

<i>31st Dec. × 1</i>		<i>1st Dec. × 1</i>	
	Rs.		Rs.
Cash	21,000	Balance (b/f)	60,000
Balance (c/f)	99,000	31st Dec. '82	
		Materials Control	47,000
		Fy. overhead	13,000
	<u>Rs. 1,20,000</u>		<u>Rs. 1,20,000</u>

17. SALES

<i>31st Dec. × 1</i>		<i>1st Dec. × 1</i>	
	Rs.		Rs.
Balance (c/f)	5,71,000	Balance (b/f)	5,25,000
		31st Dec. ' × 2	
		Credit Sales	46,000
	<u>Rs. 5,71,000</u>		<u>Rs. 5,71,000</u>

18. FACTORY COST OF ALES

<i>31st Dec. × 1</i>		<i>31st Dec. × 1</i>	
	Rs.		Rs.
Balance (b/f)	4,75,000	Balance (c/f)	5,16,000
31st Dec. ' × 2			
Finished Stock	41,000		
	<u>Rs. 5,16,000</u>		<u>Rs. 5,16,000</u>

Trial Balance on 31st Dec. 19x1

	Dr. (Rs. '000)	Cr. (Rs. '000)
10. Fixed Assets	100	
11. Capital and Reserves		310
12. Work-in-Progress (Standard)		
Materials	74	
Direct Wages	24	
Fy. Overhead	20	
	118	
13. Finished Stock	126	
14. Sundry Debtors	105	
15. Cash in Bank	10	
16. Sundry Creditors		99
17. Sales		571
18. Fy. Cost of Sales (Standard)	516	
19. Materials Price Variance	19	
20. Direct Wages Variance		4
21. Fy. Overhead Variance		10
	<u>Rs. 9,94,000</u>	<u>Rs. 9,94,000</u>

If the Materials Control, Direct Wages Control, and Fy. Overhead Control Accounts are not separately maintained, the Work-in-Progress Account will be posted as follows —

12. WORK-IN-PROGRESS ACCOUNT

<i>1st Dec. x 1</i>		<i>31st Dec. x 1</i>	
	Rs.		Rs.
Balance (b/f)			
Finished Stock			
Materials	75,000	Materials	46,000
Direct wages	25,000	Direct wages	24,000
Fy. Overhead	15,000	Fy. Overhead	14,000
	<u>1,15,000</u>		<u>84,000</u>
Cash :		Material Price Variance	2,000
Wages	22,000	Fy. Overhead Variance	2,000
Fy. Overhead	8,000	Balance (c/f)	
Creditors :		Materials	74,000
Materials	47,000	Direct wages	24,000
Fy. Overhead	13,000	Fy. Overhead	20,000
Direct Wages Variance	1,000		<u>1,18,000</u>
	<u>Rs. 2,06,000</u>		<u>Rs. 2,06,000</u>

Summary of Ledger Entries. The ledger entries for the various transactions made under the cost ledger accounting and integral accounting systems are summarised in the chart in Fig. 6.1. The accounting entries relating to specific transactions have been further illustrated at appropriate places in other chapters of the text wherever those transactions have been discussed.

Valuation of Stock. Valuation of stock refers to the ascertainment of the value of the closing balances of raw materials, stores, and part finished and finished goods for the purpose of carry over from one accounting period to another. The

correctness of the profit or loss as reflected in the Profit and Loss Account and of the assets exhibited in the Balance Sheet, depends largely upon the correct and appropriate valuation of the closing stock.

Valuation of Materials. While in the cost records the stock of materials is always valued at cost, the valuation for the purpose of financial accounts and statements is at cost or market price, or the lower of the two.

The principal argument for valuing closing stock at cost is that because the materials are meant for utilization in future periods, the current profit or loss should not be modified by adopting a value other than actual cost. An advantage of the cost method is that the stores ledger readily furnishes the information and no adjustment is necessary. The value of the closing balance in the stores ledger depends upon the method of pricing of issues adopted such as the average cost, first-in first-out, last-in first-out, etc. The average method smoothens price fluctuations and thus the closing balance under this method may conform very nearly to the actual current cost. In the first-in first-out method, the closing stock may have a fairly close relation to the replacement price, unless some stores at old prices are lying in stock for a long time and prices at which stores are received currently are higher than the previous prices. When prices are falling, this method reduces the net profit shown in the Profit and Loss Account while the profits go up during periods of rising prices. The position is reversed, when the last-in first-out method is adopted; the value of stock is deviated far from the current costs. If prices have fallen, the value of stock which consists of old purchases is overstated. Similarly in the standard cost method, if there is a significant favourable price variance and no adjustment in respect of the variance is made, the stock at standard cost would be overvalued.

Valuation of Work-in-Progress and Finished stock. The valuation of work-in-progress is made on the basis of cost which includes the cost of materials, labour, and the proportionate factory overhead. The various methods used for determining the cost of work-in-progress have been discussed at appropriate places in this text.

The valuation of the finished stock differs somewhat from the work-in-progress valuation, and it follows the general rule of valuation at cost or market price, whichever is lower. Where, however, finished stocks mature with age, e.g. in the case of wine, timber, etc., the valuation may be above cost but not above the market price. This principle is also applied in the valuation of such raw materials which appreciate in value with the passage of time. The various aspects of the 'cost or market price' principle apply in the case of finished stocks as well. The discussion which follows is, therefore, confined to the methods of determining the cost of finished stock.

The cost of finished stock would normally be the total or full cost, i.e. direct labour, direct materials, direct expenses, and the appropriate amount of overhead. As selling and distribution expenses pertain only to the sales and distribution of goods sold, these are not included in costs for the purpose of determining the cost of finished products. Similarly, the portion of administration expenses relating to the selling and distribution is excluded. There is, however, a difference of opinion whether overhead cost should be a part of the valuation, and if so, whether it should include all overhead expenses or whether fixed overhead should

be excluded. Based on this, there are two other methods of costing finished stock, viz. prime cost method and marginal cost method. The particular method adopted would depend upon the nature of the business and the circumstances obtaining.

Valuation of finished stock at prime cost, i.e. after exclusion of all overhead expenses from the total costs may be recommended in a few cases where :

- (i) There is heavy fluctuation of production and sales and the stock level widely differs from year to year.
- (ii) There is an acute competition so that full costs cannot be recovered.
- (iii) Stocks are kept for a long time to mature, and recovery of the overhead from the selling price may not be certain.

The arguments against the prime cost method are :

- (i) After all, overheads are meant to provide production facilities and there can be no production without overhead.
- (ii) True costs of production are not reflected : value of stock is understated and profit is distorted.

Valuation of finished stock at marginal cost is based on the contention that fixed costs being period costs should not be carried forward but should be completely charged direct to cost of sales. The method has, however, the following *disadvantages* :—

- (i) The stock is understated.
- (ii) The profits will differ from the profits worked out under the conventional method, depending upon the difference between the opening and closing stocks in a period.
- (iii) Marginal cost valuation is not acceptable by income tax authorities.
- (iv) Understatement of value for insurance purposes may result in significant real loss as full value will not be realised from the insurance company in case of actual fire etc.

EXAMINATION QUESTIONS

1. (a) Show the advantages of maintaining a Cost ledger.
 (b) Insert specimen entries in the following accounts of a Cost ledger, explaining from what sources such entries are normally obtained ;
 Stores Ledger Account
 Wages Control Account
 Factory Overhead Control Account
 Work-in-Progress Account
 Finished Stock Control Account
 Cost of Sales Account
(I. C. W. A., Inter)
2. Indicate the reasons why it is necessary for the cost and financial accounts of an organisation to be reconciled and explain the main sources of difference which would enter into such a reconciliation.
(I. C. W. A., Inter)
3. What procedure would adopt for ensuring reconciliation at the end of an accounting period between the overhead charged in the Cost Account and that shown in the Financial Accounts?
(I. C. W. A., Inter)

4. The balance on 1st December, 1982 in a company's job cost ledger control account was £87,623, during the following month transactions took place as follows :

	£
Direct wages incurred	3,096
Direct materials issue	12,114
Completed work invoiced (cost)	52,868
Factory overhead incurred	5,863
Materials price rebates (on jobs)	121
Special purchases (for jobs)	764
Sub-contractors' charges	823
Direct expenses incurred	1,137
Materials returned to store	406
Suppliers' credit notes—special purchases	239
Contractors' credits	487

You are required to :

- (a) Write up and bring down the balance on the control account.
 (b) State what the balance represents. (I. C. M. A., Inter)
5. On 1.1.84 the following balances appear in the books of Bharat Industries Ltd. :

	Rs.
Stores control A/c.	3,580
W.I.P. Ledger control A/c.	6,162
Finished goods ledger control A/c.	5,138

From the information given below write the cost ledger and prepare a trial Balance as on 31.12.84 :

	Rs.
Direct wages	40,380
Indirect wages—Factory	4,200
—Administration	6,910
—Selling	8,250
Factory Expenses	12,700
Administration Expenses	8,600
Selling Expenses	4,950
Sales	1,50,000
Loss on sale of plant	1,200
Materials purchased	50,620
“ returned to suppliers	2,600
“ transferred from Job No. 10 to 12	750
“ issued to Production Department	49,320
“ issued for repair work	680
“ returned by Production Department	1,210
“ loss in normal course	400
Factory overhead absorbed	15,300
Administration overhead absorbed	18,100
Selling overhead absorbed	8,200
Cost of goods produced	1,07,000
Cost of goods sold	1,20,000

(C. U., M. Com.)

6. The following balances are extracted from a company's cost ledger as at 1st March :

	Dr.	Cr.
	£	£
Raw material—control account	50,836	
Work-in-Progress—control account	12,745	
Finished stock—control account	25,980	
Nominal ledger—control account		89,561
	<u>£89,561</u>	<u>£89,561</u>

Further transactions took place during the following quarter, as follows :

	£
Factory overhead allocated to work-in-progress	11,786
Goods finished (at cost)	36,834
Raw materials purchased	22,422
Direct wages allocated to work-in-progress	8,370
Raw materials issued to production	16,290
Cost of goods sold	41,389
Raw materials credited by suppliers	836
Customer's returns (at cost) of good finished stock	2,856
Inventory audit—raw material losses	1,236
Work-in-progress rejected (with no scrap value)	1,764

You are required to :

(a) Write up the four accounts in the cost ledger

(b) Schedule the remaining balances.

(J. C. M. A., Inter)

7. As at 30th September, 1960, the following balances existed in a company's integrated account :

Balance Sheet Accounts .	£'000
A/c code 10 Fixed assets	300
20 Materials in store and process	115
21 Direct wages in process	20
22 Variable overhead in process	10
30 Finished stock	150
40 Cash at bank	20
50 Share capital	100
60 Trade creditors	80

Trading Accounts :

A/c code 100 Sales	370
110 Marginal cost of sales	200
120 Absorption variance—wages	3 (debit)
121 Absorption variance—variable overhead	2 (debit)
125 Fixed overhead	30

Sales are made on a cash basis. During the quarter to December, 1960 the following transactions took place :

	£'000
Sales	120
Purchases on credit—raw materials	57
variable overhead	57
rent, insurance, etc.	14
Cash Payment—creditors	8
„ direct wages	70
„ indirect wages	12
„ management salaries	5
Output finished (materials—£80 ; wages—£25) .	
variable overhead stock—£20)	125
Cost of finished stock sold	67
Closing valuations of work-in-progress accounts are :	
Direct wages	6
Variable overhead	16

You are required to write up and close off the account and schedule the closing balances.

(J. C. M. A., Inter)

- 8 Some of the balances in a company's integrated accounting system as at 30th November are as follows :

Account Code	£'000
10 Creditors	116
11 Materials in stock and in progress—at standard	87
12 Wages in progress—at standard	16
13 Overhead in progress— at standard	32
14 Finished stocks— at standard	110
15 Debtors	236
16 Cash at Bank	12
17 Sales budget	1,700
18 Sales variance	24 (credit)
19 Cost of sales- at standard	1,652
20 Materials price variance	12 (credit)
21 Wages variance	2 (credit)
22 Overhead variance	5 (credit)

The following transactions took place in December .

	£'000
Sales budget	135
Sales- actual	124
Cash receipts -from debtors	134
Material purchases actual (on credit)	76
Cash payments to creditors	95
Cash payments wages	24
Overhead incurred (on credit)	52
Finished output at standard	
Materials	64
Wages	22
Overhead	44

Cost of sales - at standard 150

The standard cost of materials purchased was

The closing valuation of work-in-progress at standard were

Wages	£13,000
Overhead	£43,000

W I P is debited at actual and credited as standard

You are required to write up the ledger accounts and to bring down the closing balances (1 C M A., Inc.)

- 9 Give consolidated journal entries in respect of the following information to give effect to integrated standard wage cost accounting. Your entries should be grouped under the following heading
- Wage payments
 - Wage analysis .
 - Wage standards and variances

The bases of your calculations are to be shown on a page separate from the journal entries

Net wages cheque	7,840
National insurance cheque (employer's and employers' contribution)	640
Employees' deductions accrued	
P. A. Y. E. tax	490
State graduated pension	280
Hospital fund	140
Employers' contribution + State graduated pension	280

Gross wages allocated (including graduated pension and national insurance costs) :

		£
Direct wages	: Department A	2,850
	: Department B	4,186
Indirect wages	: Department A	780
	: Department B	560
Clerical wages	: Department A	440
	: Department B	274
Welfare costs	: Department A	230
	: Department B	150

	Department	
	A	B
Standard wage cost and output :		
Standard wage cost per hour	6s. 8d	7s. 6d
Actual hours worked	9,000	10,920
Actual wage cost per hour	6s. 6d	7s. 8d.
Finished output (in standard hours)	8,400	11,360

(Work-in-Progress is debited at "actual" and cleared with "Standard and Variances")
(I. C. M. A., Part II)

10. (a) The Cost Accounting Record Rules and the Cost Audit Report Rules provide for reconciliation of the profit/loss as per the Cost Records with the profit/loss as per the Financial Records. What is the main object of stipulating such a reconciliation?

- (b) The following figures have been extracted from the Cost Records of a manufacturing unit :

Stores : Opening balance	Rs. 30,000
Purchases	Rs. 1,60,000
Transfer from work-in-progress	Rs. 80,000
Issues to work-in-progress	Rs. 1,60,000
Issues to Repairs and Maintenance	Rs. 20,000
Deficiencies found at stock-taking	Rs. 6,000
Work-in-progress : Opening balance	Rs. 60,000
Direct wages applied	Rs. 60,000
Overheads applied	Rs. 2,40,000
Closing balance	Rs. 40,000

Finished products : Entire output is sold at a profit of 10% on actual cost from work-in-progress.

Others : Wages incurred for the period, Rs. 70,000 ; Overheads incurred for the period Rs. 2,50,000.

Items not exhibited in Cost Records : Income from investments, Rs. 10,000 ,
Loss on sale of capital assets, Rs. 20,000.

Draw up Stores Control Account, Work-in-progress Control Account, Profit and Loss Account, Costing Profit and Loss Account and the Reconciliation Statement.

(I. C. W. A., Final)

CHAPTER 7

PRODUCT COSTING METHODS

JOB ORDER COSTING

Features of Job Costing or Job Order Costing. Industries which manufacture products or render services against specific orders as distinct from continuous production for stock or sales, use the job costing or job order method of cost accounting. The method is also known under various other names, such as specific order costing, production order costing, job lot costing or lot costing. Every order in job costing is separate and it is not essential that the same manufacturing operations be carried out or the same materials be utilized in respect of each. However, a number of identical orders or identical products may be combined together to form lots or batches, each such lot or batch constituting a job order. In the job costing system, an order or a unit, lot, or batch of a product may be taken as a cost unit, i.e. a job. The cost of a job is determined under the various elements, i.e. labour, material, and overhead in as much detail and with as much refinement or extent of analysis as necessary, but these are always related to a specific order.

In job costing, there is no averaging of costs except to the extent that in the ascertainment of unit cost, the cost of a lot of products in one order is obtained. A job or an order may extend to several accounting periods and job costs are, therefore, not related to particular periods. These and several other features distinguish job costing from process costing. We shall discuss these differences in detail in the next section dealing with process costing.

Situations where job cost accounting would be more suitable than process costing may arise in the following three types of manufacturing organisations :—

- (a) *Jobbing concerns*. Some concerns manufacture a variety of products according to customer's specifications and do not generally confine their activities to producing uniformly any specific product for sale in the market. The jobs, products or services are dissimilar or unique and non-repetitive having different specifications and methods of manufacture, and each one requires different types, sizes, and quantities of materials and equipments and utilizes different labour hours. Such concerns must of necessity use job cost accounting.
- (b) *Small firms*. Though manufacturing a number of specific products, small manufacturing concerns may find process costing difficult to apply because due to small sales, no product can have a run long enough to establish a product line. A product is manufactured for a few days but when demand falls, another product is taken up, only to be changed over again to a third one after the next few days. On account of the frequent changes from one product to another, job costing would be suitable for determining the cost of each lot of products.

- (c) *Large enterprises manufacturing a variety of products* : The situation mentioned in the preceding paragraph may also arise in large firms which manufacture a large variety of products for the market. A single department would be manufacturing several products, perhaps all at a time, so that none of the departments is specialised for continuous runs of product lines. As definite process departments cannot be established, job costing is more suitable in such cases.

Job costing is applicable to engineering concerns, construction companies, ship-building, furniture making, hardware, and machine manufacturing industries, repair shops, automobile garages, and several such other industries where jobs or orders can be kept separate.

Procedure for Job Cost Accounting. As production in a job order system is not a continuous process, careful planning and strict control is essential to avoid wastage of materials, manpower, machinery, and other resources. On receipt of an order from the customer or on an indication from the sales department for manufacturing a particular product, the production planning department prepares a suitable design for the product or job. It also works out the requirements of materials for the product (in the form of a bill of materials) and prepares a list of operations (in an operation schedule) indicating the various operations to be carried out and their sequence, and the shops, departments, plants, or machines to be entrusted with each of the operations. As the flow of costs closely follows the production programme, the layout of the production plan assists in determining the nature and point of incidence of costs.

A *Production Order* (see Fig. 7.1) is issued giving instructions to the shops to proceed with the manufacture of the product. The production order (also known as *Work Order* or *Job Order Record*) constitutes the authority for work. As a matter of fact, the production order is the hub or key point from where production starts and the job cost is worked out. The detailed information contained in a production order and the purpose for which they are used vary widely from one concern to another. Usually a production order contains all relevant information regarding production, such as detailed particulars of the job or product, the quantity or units to be manufactured, date of start of production, probable date of completion, details of materials required as per the bill of materials, the operations and the various shops involved in performing them and the route the job should take. If the items of materials and the labour operations are too many, only a summary of material and labour is given on the production order with cross reference to the bill of materials and the operation schedules, where the details are available.

A production order is issued for a single run only, e.g. if a production order states that 100 units are to be manufactured, it would mean that 100 units constitute a run and that as soon as 100 units are completed the production order is closed. If more units are desired to be manufactured in a subsequent lot, a fresh production order should be issued. The number of units included in a run or lot depends upon several factors, such as the nature of production, availability of plant and other facilities, setting up costs, and convenience in manufacture. The question as to what should constitute the economic or optimum quantity to be taken up

The production order usually lays down only the quantities of materials required and the time allowed for the operations, but the values of materials and labour are also sometimes indicated. In the latter case, the production order serves the combined purpose of an order for manufacture as well as the cost sheet on which the cost of the order is compiled. In some cases, sales price, customer's name, shipping instructions, etc. are also mentioned in the production order.

The production order also provides for the material and labour on account of normal wastage or spoilage of the product in the final stage or during the various stages of manufacture. Alternatively, the production order is short closed at the quantity of good products actually manufactured and a separate production order (properly linked with the original production order) is placed for the manufacture of the actual quantity wasted or spoiled.

Production orders may, in general, be of three types :

- (i) *Assembly type of order* : Where components are purchased and assembled into a product in the factory, a production order for assembly only is required.
- (ii) *Sub-assembly type of order* : Components are purchased and sub-assemblies and assemblies are made in the factory. Production orders for each sub-assembly and final assembly will be necessary.
- (iii) *Components or parts production type* : Components are manufactured and sub-assembled and the sub-assemblies are assembled into the final product. Separate production orders for each component, sub-assembly, and final assembly are issued.

Every production order is assigned a number called the *Job number, job order number, production order number, or work order number*. The numbers are assigned serially to each job or batch of products. Sometimes the serial numbers are elaborated, if required, by adding codes to indicate further information. Where jobs are of a repetitive nature, the production order numbers may be so designed as to show, besides the particular batch of production, the type or class of the job or product.

Copies of production orders may be distributed as follows :—

- (i) One copy to the stores for provisioning and issue of materials on demand. For new or special types of materials, a purchase requisition is prepared by the planning department and sent to the purchase department for provisioning action.
- (ii) One copy each to the departments or shops concerned to undertake production by demanding materials and employing men and machines on the operations.
- (iii) One copy to the cost department for working out the cost of the job. On receipt of the copy, the cost department opens a Job Cost Sheet or Card (Fig. 7.2) which bears the production order number and other details relating to the job as indicated in the production order.

[illegible]

Fig. 72 Job Cost Sheet (or Card)

Note: Overhead cost may be split up and shown separately as Factory, Administration, and Selling and Distribution Overhead

Separate job cost sheets are maintained for each job. If a job consists of several major or important operations (or components), separate cost sub-sheets for recording the costs of the various operations may be maintained and the aggregate cost, in summary, shown in the main or master cost sheet. Job cost sheets do not relate to specified periods but they are made out for each lot, batch, or run of production regardless of the time taken for its completion. Costs

incurred in respect of a job, under the various elements, i.e. labour, material, and overhead are posted periodically (usually monthly) to the relevant cost sheet. Thus, posting of data as and when they accumulate assists in control over the job while it is still in the process of manufacture. Columns are provided in the cost sheet to record the predetermined (standard or estimated) cost along with historical (i.e. actual) costs so that besides recording the actual costs, a cost sheet serves as a medium for performance evaluation and cost control.

The basic principles and procedures in the accounting of material, labour, and overhead costs discussed in the previous chapters are normally applicable to job costing. Some special features of the job cost system are, however, mentioned below.

Material Cost. On receipt of a production order, the shop draws the requisite materials from the stores. The drawals are made on materials requisitions on the authority of the bill of materials or on excess materials requisitions if the quantity provided in the bill of materials is not sufficient. The particular job order number for which material is drawn is indicated in each requisition. Sometimes the drawal is made direct on bills of materials and preparation of materials requisitions is dispensed with. Surplus, excess, or incorrect materials are returned from the shops to the stores on materials return notes. Scrap and waste arising in the course of manufacture are returned in a similar manner. As in the case of material requisitions, materials return notes bear the appropriate job order number. Similarly, the credit and debit job order numbers are indicated in the materials transfer notes through which materials are transferred from one job to another. The materials requisitions, materials return notes, and materials transfer notes are 'costed' in accordance with the methods of pricing adopted by the concern. Indirect materials, i.e. materials which cannot be identified with specific jobs are also drawn as required, on materials requisitions. Such requisitions are made out against one or the other standing order numbers depending on the purpose for which the materials are drawn.

A periodical analysis of materials requisitions, materials return notes, and bills of materials is made and posted in the materials requisitions journal. The monthly totals are posted in the General Ledger by credit to Stores Control Account and debit to Work-in-Progress Control Account and Overhead Control Account for direct and indirect materials respectively. For cost accounting purposes, a materials issues analysis sheet (see Fig. 2.24) is prepared showing the cost of materials issued against the various job order or production order numbers and standing order numbers. Direct material cost is posted on the cost sheet relating to the particular production order; indirect material cost forms a part of the overhead costs.

Labour Cost. Job type of industries may employ the day work system as well as one or more of the various methods of remunerating labour on results, as found suitable. On the authority of operations schedules, time is booked on time sheets, job cards, time tickets or piece-work cards. The job cards are valued by the cost department; the wages paid are classified into direct and indirect

labour and booked to production order and standing order numbers respectively. Labour summaries or wages analysis sheets (see Figs. 3.20 and 3.21) are prepared for each accounting period and the totals of these statements are debited to Work-in-Progress Account or Overhead Control Account by credit to Wages Control Account. Amounts on account of overtime, idle time, shift differential, and fringe benefits may also be included in the wages analysis sheet. Direct labour costs are posted on the respective cost sheets and indirect labour is treated in the manner indicated for indirect material.

Direct Expenses. Examples of direct expenses, which are directly chargeable to cost units are given on Page 199. The relevant direct expenses chargeable to a particular production or job order are posted on the respective cost sheet in a separate column opened for the purpose.

Manufacturing Overhead. Overhead costs are accumulated against standing order numbers and against cost centres. Overhead rates, predetermined or actual as the case may be, are worked out for each such centre. The overhead applied to each job is obtained by multiplying the overhead rate by the *actual* base variable (e.g. direct labour, labour hours etc.) spent on the job. The amount of overhead cost applied to each job order is summarised in an Overhead Absorption (or Applied Overhead) Analysis Sheet (see Fig. 4.14) and is posted on the relevant cost sheets along with the direct material and direct labour costs and direct expenses.

The control accounting of job cost is illustrated in the flow chart in Fig. 7.3.

Completion of Jobs. Postings of direct material, direct labour, direct expenses and manufacturing overhead costs to the cost sheet for a job or production order are made periodically throughout the run of the job or order. As soon as the job is completed, a job completion report is sent by the production shop to the production planning department, with a copy to the cost office. Sometimes the information regarding completion is noted on the production order which is routed through the cost office. The completion report is an indication that the manufacturing operations are over and further expenditure on the job should cease so that the cost sheet may now be closed. The expenditure booked under each element of cost is totalled up and the grand total of costs is arrived at. The total cost divided into the units of output gives the cost per unit of the job. In many cases, a Finished Stock Card (see Fig. 7.4) which keeps a day-to-day record of the units completed on a production order is maintained. When the job is completed, the quantity recorded on the finished stock card is totalled up and the total number of units completed is posted on the job completion report or the production order, as the case may be. The finished stock card may also be utilised for recording the issue or despatch of finished good.

If monthly accounts are maintained, the cost of a completed production order can be determined only after the end of the month, even if the job is completed in course of the month. In certain cases, e.g. in cost-plus contracts or in the case of manufacture of products to customers' specifications where billing is to be done immediately, this period of waiting cannot be afforded. Costs are,

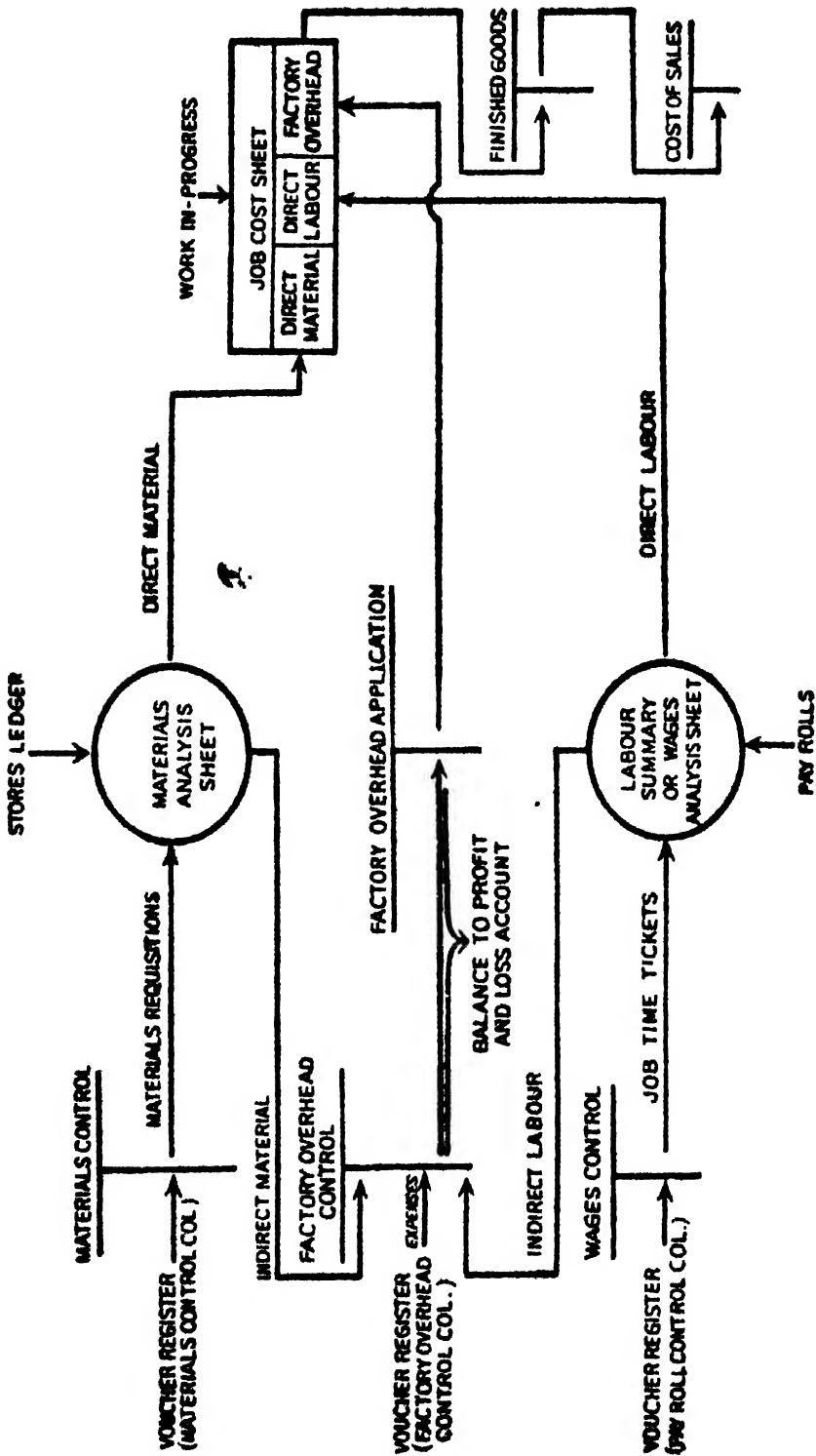


Fig. 7.3. Control Accounting for Job Costing

therefore, determined immediately on the day an order is completed. This may be done more easily when standard costing or predetermined labour and overhead rates are in use.

Work-in-Progress. The cost of an incomplete job, i.e. a job on which some manufacturing processes or operations are still due before it can be made into the finished product is termed Work-in-Progress or Work-in Process. If a

FINISHED STOCK CARD		
Department Period		Production Order No. Specification
Receipt	Issue	Balance

FIG. 7.4 Finished Stock Card

Note. If several production orders are issued for an item of production the card should provide an additional column to record the production order or job order number.

production order has been only partly completed by the end of an accounting period, it is essential that the closing stock of the work-in-progress be determined. Unless this is done, the cost of production of those of the units on the order that have been completed cannot be correctly determined and the profits for the period will be distorted. Determination of work-in-progress at frequent intervals is essential where periodic Profit and Loss Account is required to be prepared for control purposes without reference to the closure of the accounting period.

In job cost accounting, the cost of closing work-in-progress is obtained from the Work-in-Progress Account where it appears as a balance entry supported by job cost sheets. The work-in-progress against each job is computed at the end of the accounting period. When no unit on a production order has been completed, as in the case of whole jobs, the entire cost booked on the order constitutes the work-in-progress. If only some out of the total number of units on a production order have been completed, the value of the closing stock of work-in-progress is deducted from the total expenditure to arrive at the cost of the units completed. While it may be possible to determine the quantity of material still in process by actual weighing, counting, etc., the costs of labour and overhead are prorated between the finished product and the incomplete production. The work-in-progress at the end of an accounting period is carried over on job cost sheet, as the opening stock in the subsequent period to which is added the expenditure further incurred on the job in that period.

An illustration showing the method of calculation of the value of work-in-progress is given below :

EXAMPLE 7.1.

The quantity specified on a production order was 2,000 units of an article in the manufacture of which four operations were involved. The piece-rates for these four operations were in sequence, Re. 0.20, Re. 0.25, Re. 0.20 and Re. 0.30 per unit. The company recovered factory overhead expenses on the basis of direct labour cost and the current overhead rate is 80%. The entire quantity of material authorised for the order, viz, 1,000 kgs. @ Rs. 2 per kg. was issued to the shop. Of this, 50 kgs. were returned as scrap arising in course of manufacture, valued at Rs. 8 (wastage occurring in the various stages has not been shown).

At the year-end, the order was incomplete ; only 200 units were fully completed and transferred to finished stock. Stock-taking of the work-in-progress revealed the following position :

Material in process	650 kgs
Material in hand, in shop, unprocessed	200 kgs
Production in partly completed stage	1,300 units

Extent of work performed :

Up to the 1st operation stage	600 units
Up to the 2nd operation stage	400 units
Up to the 3rd operation stage	300 units
Up to the 4th operation stage	Nil

You are required to calculate the cost of the work-in-progress at the year-end

ANSWER :

The cost of work-in-progress will be .

Material cost :

Material in hand 200 kgs. @ Rs. 2 per kg		Rs. 400.00
Material in process 650 kgs. @ Rs. 2 per kg.	Rs. 1,300.00	
Less proportionate cost of scrap	Rs. 6.50	
		Rs. 1,293.50
		Rs. 1,693.50

(Scrap is credited to the finished production and work-in-progress in proportion to the material consumed for each)

Labour Cost :

Operation 1—600 units ∴ Re. 0.20	Rs. 120	
Operation 2—400 units (Re. 0.20 + Re. 0.25)	Rs. 180	
Operation 3—300 units (Re. 0.20 + Re. 0.25 + Re. 0.20)	Rs. 195	
	— — —	Rs. 495.00

Factory overhead cost (80% on direct labour)

Rs. 396.00

Total cost of work-in-progress

Rs. 2,584.50

(The total cost booked to the production order less the cost of work-in-progress will give the cost of 200 units of the articles completed during the year.)

Cost Control in Job Order System. Compared to the process type of manufacturing, the problems of cost control in job order type of organisations are more complicated because each job is separate from the rest and jobs are mostly not repeated. Further, several jobs are handled in a department and further subdivision of the department for each job is not possible.

Control over job costs may be exercised by comparison of the actual costs with the estimated costs established as basis for fixing job prices. Here again, adequate cost control is available for direct material and direct labour only overhead costs cannot be controlled in terms of individual jobs. Control of overhead is, therefore, confined to the department as a whole for which predetermined overhead rate has been determined.

Comparison may also be made with the costs of previous periods or of earlier batches of production, if any. If there are several units under the management of the concern, comparison of costs of identical products manufactured in more than one factory may be useful.

Standard costs may be used in job type plants, particularly where the product or the particular operations of the job are of a standardised nature. Standard costs provide a firm basis for preparation of cost estimates of specific jobs and thus serve as a powerful tool for cost control.

Advantages and Limitations of Job Costing. Job costing offers the following specific advantages :—

- (i) The cost of material, labour and overhead for every job or product in a department is available daily, weekly, or as often as required while the job is still in progress. This enables the management to know the trend of costs and thus by suitable comparison, to control the efficiency of operations, materials, and machines.
- (ii) On completion of a job the cost under each element is immediately ascertained. Costs may be compared with the selling prices of the products in order to determine their profitability and to decide which product lines should be pushed or discontinued or whether prices or price quotations could be revised. The application of marginal costing techniques (discussed in another chapter) may be useful in such situations.
- (iii) Historical costs for past periods for each product, compiled by orders, departments, or machines, provide useful statistics for future production planning and for estimating the costs of similar jobs to be taken up in future. This assists in the prompt furnishing of price quotations for specific jobs.
- (iv) The adoption of predetermined overhead rates in job costing necessitates the application of a system of budgetary control of overhead with all its advantages.
- (v) The actual overhead costs are compared with the overhead applied at predetermined rates, thus, at the end of an accounting period, overhead variances can be analysed.
- (vi) Spoilage and defective work can be easily identified with specific jobs or products so that responsibility may be fixed on departments or individuals.
- (vii) Job costing is particularly suitable for cost-plus and such other contracts where selling price is determined directly on the basis of costs.

The *limitations* of job costing are :

- (i) Job costing is comparatively more expensive as more clerical work is involved in identifying each element of cost with specific departments and jobs.
- (ii) With the increase in the clerical processes, chances of errors are enhanced.
- (iii) The cost as ascertained, even where they are compiled very promptly, are historical as they are compiled after incidence.
- (iv) The cost compiled under job costing system represents the cost incurred under actual conditions of operation. The system does not have any scientific basis to indicate what the cost should be or should have been, unless standards of performance efficiency are established. Estimated costs, prepared by some concerns in respect of job orders, also do not serve the purpose.
- (v) If major economic changes take place, comparison of cost of a job for one period with that of another becomes meaningless. Distortion of cost also occurs when the batch quantities are different.

Tools Control and Treatment of Tool Costs. Tools (including jigs, fixtures, dies, gauges, etc.) constitute a very important and essential requirement of production in an industrial unit, and in many concerns, tool costs form a significant part of production costs. An effective system of control of tools is, therefore, necessary not only for economising and reducing tools costs but also to ensure that there is uninterrupted smooth flow of products of requisite quality with the help of the proper tools.

The *advantages* of an effective system of tools control are :

- (i) Reduction in the lock up of capital in tools inventory.
- (ii) Supply of the proper type and quality of tools to the production shops ensures quality of products.
- (iii) Suitable tools reduce product costs by minimizing wastage and scrap and reducing operation time.
- (iv) The control system aims at reduction of tools costs and avoidance of loss and pilferage of tools.
- (v) The system includes a procedure for salvage of old tools
- (vi) Sufficient quantity of standard tools is always available in stock and special tools are provided at the proper time, before production starts. This assists in production planning and control.

The various steps involved in the control of tools are as follows : –

- (a) *Proper designing of tools* : The requirements of tools for various jobs, operations, processes, etc. are laid down by the methods engineer, who is also responsible for making tool designs, wherever necessary. In order to reduce costs, tools are standardised as far as practicable.
- (b) *Consideration of the necessity for special tools* : Whether such tools should be manufactured or purchased.

- (c) *Purchase of tools* : The normal system of purchase in respect of materials may be adopted for the purchase of tools
- (d) *Classification, recording, and accounting of tools* This includes a plan for charging of tool costs to various jobs, operations, processes etc. discussed later in this section
- (e) *Laying out a system of control of inventory of tools* The procedure applied for materials storage and control may be adopted After classification, each type of tool is recorded in bin cards and in a *tools ledger* The latter is, in fact a part of the stores ledger and separate volumes of the stores ledger are earmarked to record transactions relating to tools The various levels may also be fixed in the usual manner for each type of tools Physical stock verification of tools is carried out in the same manner as for other stores but costly tools may be verified more frequently
- (f) *Periodical inspection of tools* This is essential in order to ensure that tools of the requisite quality will be available whenever required for production Inspection is necessary when tools are returned from the production departments so that their residual life and value may be assessed and a correct charge made to the job operation process, etc for which they were utilized
- (g) *Provision of a procedure for timely repairs maintenance and replacement of tools as necessary*
- (h) *Providing an adequate system of control of physical issue and return of tools*

Issue of Tools to Workers –Usually there is a separate Tools Store or Tools Crib, or a godown in the main store set aside for keeping stocks of tools The issue of tools may be regulated under any of the following methods

- (i) *Tools are kept with the workers* A tool kit containing common tools required for daily use is issued permanently to a worker who is made responsible for its safe custody and upkeep Renewals and replacements of tools used up, worn off, or lost are made after proper scrutiny and only after the old tools (except in the case of loss) have been returned Additions are made as and when necessary
- (ii) *Issue on employees tool cards* In this method a worker is issued a tool card Whenever he is in need of a tool, he goes to the tool crib and produces his card The requisite tool is issued to him after making a note of the particulars of the tools, in his card Suitable entries are made again when the tool is returned back In a variant of this method, known as the double check system, the employee's tool card is hung up alongside the tool rack from which a particular tool has been issued Each bin has also a corresponding tool bin card When the employee's tool card is placed on the bin, the tool bin card is taken out and hung on a control board against the workman's ticket number This method indicates the whereabouts of the issued tool and provides a ready list of tools issued to a workman On return of the tool, the card is returned to the worker and the bin card is placed back in the tool bin.

Employees' tool card system enables the assessment of efficiency in tool utilization as well as of any loss or damage of tools. The system however, involves waste of time on the part of the workers and there might be machine breakdowns and production hold-up due to the routine delay in the issue of tools.

- (iii) *Tools issued on requisitions* : In this method, tools are issued against requisitions only, as in the case of issues of stores on materials requisitions, and the returns are watched. A list of tools required is sent in advance to the tools store so that the tools may be kept ready for issue.

Accounting of tool costs There are four methods of allocating the costs of tools :

- (i) *Direct charge* : Tools required for special purposes and those purchased for a particular job, project, or contract are allocated direct to the relevant cost unit. When a special tool is required for more than one job, the cost of the tool should be apportioned to the various jobs on the basis of the number of hours for which the tool was utilized on each job. Alternatively, some other technical basis may be adopted for apportionment. The hourly rate for charging the cost of a tool may be computed as shown below :

$$\text{Hourly rate (Rs)} = \frac{\text{Cost of tool} + \text{Estimated cost of maintenance, repairs, etc}}{\text{Estimated working hours during the assessed life of the tool}}$$

If a job, utilizes the services of the tool for x hours, the tool cost allocated to the job will be Rs $(R \times x)$.

The difference between the amount charged and the actual cost (which should not normally be very significant) is either treated as overhead or adjusted in the subsequent revised hourly rate.

- (ii) *Capitalisation of tools* : Costly tools and tools expected to be used for a considerable number of years are capitalized and treated as fixed assets. Depreciation is calculated in the usual manner for each tool and allocated to the departments or products which make use of the tool. Another method of charging the cost to job etc. is to revalue the tools after their utilization, i.e. on the completion of each job ; the difference between the values before issue and after consumption represents the amount to be charged.

The cost of small tools may also be capitalized. Instead of having separate records for each tool in the plant or asset register as in the case of costly tools, small tools may be pooled together and charged to a Capital Asset Account, known as Small Tools Account. The value of the small tools as recorded in this account is periodically depreciated and depreciation charged to production costs. The determination of the amount of depreciation, however, is sometimes difficult because it is not always possible to correctly fix a suitable life for all such small tools and when tools of different types are combined together, it becomes practically impossible to determine a

common life for all of them. The revaluation method may, therefore, be applied with advantage in the case of small tools. The aggregate of the opening balance and the purchases less the closing balance, as per the Small Tools Account, is taken as the consumption to be charged to the jobs during a specified period.

- (iii) *Treatment as items of materials* : The tools are kept on bin cards and stores ledger charge, and treated as any other item of material. When required, the tools are drawn on materials requisitions and the cost is allocated to the cost centre or cost unit concerned. In the case of small tools, the full cost is charged to the jobs etc. at the time of issue and any returns made later are credited to overhead.
- (iv) *Charge to overhead cost* : This method is applicable in case of small tools the cost of which is not high. At the time of purchase, the cost of the tools is charged to manufacturing overhead. The cost is collected by an analysis of the purchase vouchers and is booked to a Standing Order Number. The entire expenditure is allocated to tool room or tool store and along with the other overhead cost of these departments, it is allocated or apportioned to the producing cost centres.

Manufacture and maintenance of tools– Besides purchase from outside, tools are manufactured in own tool room. Both special and loose tools may be manufactured for internal use and sometimes for sale to customers. The cost accounting procedure for the manufacture of tools is the same as adopted in the case of job costing or batch costing. Production orders under the name of Tool Room Orders are issued for each batch of tools and the costs of materials, labour, and overhead are booked to the respective tool room orders.

DAMAGED TOOLS REPORT					
Department			Period		
Tool No.	Cost of tool damaged	Cause of damage	Person responsible	Estimated cost of rectification	Action taken

Fig. 7.5. Damaged Tools Report

JOB COST VARIANCE ANALYSIS					
Job No. : Job description :			Date started : Date completed :		
	Actual cost	Estimated cost	Difference	Reasons for variance	
				Rate/price	Quantity, time, volume, etc.
Material					
1					
2					
3					
Labour					
Deptt. A					
" B					
" C					
Manufacturing Overhead					
Deptt. A					
" B					
" C					
Total					
Sale price					
Gross profit					

Fig 7.7. Job Cost Variance Analysis

Contract or Terminal Costing. *Contract Costing or Terminal Costing* as it is often termed, is a variant of the job costing system, applied in businesses engaged in building or other construction work. The jobs are usually the contracts (some of them on long-term basis) entered into with the customers. As the number of such contracts handled at a time by a business may not be usually large, contract costing is comparatively simpler in operation than job costing system. The basic principles applied in contract costing are the same as those used in job costing except that these are modified to suit the particular requirements of the contracts.

Contract costing *differs* from job costing in the following respects —

- (i) While the number of jobs in hand at any time in a concern may be large, only a few contracts may be undertaken at a time.
- (ii) The accumulation, analysis, apportionment, allocation, and control of costs is simplified in contract costing.
- (iii) Most of the expenses are chargeable direct to the contract account. Direct allocation to such an extent is not possible in job costing.
- (iv) As contracts may run for long periods, there arises the problem of assessment and crediting of profits on incomplete contracts at the end of the accounting period.

CONTRACT LEDGER												
Contract Price : Contract No. & Date : Contractee :			Site Completion Date .			Terms Retention Money :						
Date	Particulars	Folio	Materials	Wages	Direct expenses	Plant and tools	Indirect expenses	Total	Total cost to date	Amount certified	Amount uncertified	Payment on account

Fig 7.9 Contract Cost Ledger Sheet

Notes :

- 1. Credit entries are made in red , alternatively separate columns similar to this , on the debit side, are opened on the credit side for making credit entries.
- 2. The materials, wages, etc. columns may be further subdivided to record more detailed analysis of these items of expenditure.
- 3. When it is desired to maintain secrecy, the details on the top of the sheet may be omitted or substituted by codes.

The *special features and problems* involved in contract costing are detailed below :

(i) *Cost unit* : A contract constitutes a job, i.e. the cost unit for which costs are to be ascertained.

(ii) *Contract account* : Profit or loss is required to be worked out for each contract. Separate contract accounts are, therefore, maintained for each contract in the general ledger. A form for a Contract Cost Ledger Sheet may be seen in Fig. 7.9.

(iii) *Materials* : Control over receipt, issue, and return of materials is exercised in the manner discussed in the previous chapters. A substantial portion of the materials may be purchased specially for individual contracts. The cost of such purchase is charged direct to the contract. As contract sites are generally far off from the location of the central or main stores of the business, it is economical to transfer surplus stores, not required for a particular contract, from one site to another rather than waste time and transport expenses in returning these to the central stores and issuing them again for another contract. Inter-contract transfers are, therefore, more frequent. The transfers are made through materials transfer notes.

Materials not required for current use are sometimes sold at the site ; the cost is credited to the contract account and the accruing profit or loss, being the difference between the cost and sale value, is transferred to the Profit and Loss Account.

The customer or the contractee may supply certain materials from his own stock to be utilised in construction work. Ancillary units often carry out fabrication work on raw materials and components supplied by the principal unit (the customer). Such materials should not be debited to the contract account or fabrication account ; a separate memorandum record outside the accounts will be sufficient. The practice in some concerns is to recover a certain percentage of the value of these materials from the contractee by way of stores handling charges.

(iv) *Labour* : Contracts usually being large and on a long-term basis, it is possible to trace and charge most of the wages direct to a contract. The rest of the labour cost which cannot be so charged is booked as indirect labour. The accounting and control of labour cost is done in the usual manner. For easy identification of labour costs with individual contracts, separate wage books or sheets are maintained for each contract or alternatively, the wage books are maintained in a columnar form with separate columns for each contract so that analysis by contracts can be easily made. In case of erection jobs done at sites away from the headquarters, installation of a suitable system of recording of attendance and job time of workers at the site itself is essential.

A problem that frequently arises is due to the transfer of workers from one contract to another. In such cases, detailed time records in the form of time sheets showing the time taken for each contract are maintained. An abstract of wages (see Fig. 3.20) is prepared at the end of the accounting period for booking of labour costs to various contracts.

(v) *Plants and tools* : Cost of plants and heavy tools issued to contract sites are charged to the particular contract. After completion of the contract, the

residual book value of the plant or tool is credited to the contract account. Every time a plant or tool is transferred from one contract to another or is returned to stores, it is to be valued and credit given to the contract concerned. If a contract is not completed by the end of the financial accounting period, the plants and tools should be valued and credited to the contract account in order to arrive at the cost of the contract on date. The valuation for the above mentioned purposes is largely a matter of technical assessment made on the basis of several factors such as the extent of service already rendered by the plant or tool, its present conditions, expected life, etc. Another method of charging plant costs to contracts is on the basis of hourly rates determined for each plant. The rate is computed by dividing the depreciation and other operating expenses of the plant, e.g. salaries and wages of operating staff, power, etc. by the total estimated working hours of the plant. The charge to a contract account is determined according to the hours of the plant-time utilised by the contract. If a plant specifically purchased for a contract is sold, credit for the sale value is given to the relevant contract. If the sale value is abnormally high due to a sudden rise in price, only a reasonable price is credited to the contract; the balance representing an abnormal amount is credited direct to the Profit and Loss Account. When plants are hired for use in construction work, a suitable charge for rent is made to the contracts on the basis of the time taken or the extent of use made by each contract.

(vi) *Direct expenses* : Items of expenditure which can be allocated direct to a contract such as sub-contractors' charges (see item viii below) hire charges of plants obtained from outside, architects' and consultants' fees, electricity, insurance etc. appear, as direct expenses in the contract account.

(vii) *Indirect expenditure* : As stated earlier, most of the expenditure can be charged direct to contracts. Items of indirect miscellaneous expenses such as cost of central stores, office expenses, power costs, etc. are allocated or apportioned to the various contracts on suitable basis. The bases suggested in Chapter 4 may be adopted for the purpose. In the case of big contracts, the labour hour is the most suitable base. Indirect expenses are sometimes apportioned to the various contracts in proportion to the total expenditure incurred on each during the period under consideration. Accrued expenses, both direct and indirect, should be charged to the contract account and carried over to the next accounting period in the case of incomplete contracts.

(viii) *Sub-contract* : Sub-contracting, usually of part of the work, is another essential feature which we frequently come across in contract work. Sub-contracting may be necessary under the following circumstances :

- (a) Work of a specialised nature for which facilities are not internally available within the concern is offered to a sub-contractor.
- (b) It may be advantageous to get a part or component from outside, if it is costlier to manufacture it.
- (c) Consideration of opportunity cost, the management may not like to invest capital which may be utilized for other more profitable lines.
- (d) The capacity of the firm may be limited and in order to keep time schedule, work may be speeded up by offering it to sub-contractors.

The payments made to sub-contractors are charged in totals to the concerned contract account as direct expense and no detailed records or break-up of the

sub-contract amount is necessary for cost purposes. It, however, a sub-contract has been placed on cost-plus basis, suitable method should be evolved for checking the cost data submitted by the sub-contractor.

Situations may arise when materials are issued free to the sub-contractors, or free technical and other assistance are afforded to them. The cost of provision of such facilities should be charged to the contract account. Heavy tools and other equipments may be supplied to the sub contractors on rental basis.

The depreciation on these equipments should be charged to the contract account and the rental received credited to it or shown as deductions from the sub-contractor's bill. If more than one contract is involved, the depreciation and rental should be treated as charge and credit respectively to overhead accounts and booked in the usual manner to the cost of all the contracts.

While fixing the contract price, the sub-contractor will evidently take into account the rental paid by him. Otherwise, while billing for the work he will include an extra amount to cover the rental. The credit to the contract account for the rent received will thus be offset by the additional charge in the bill.

(ix) *Surveyor's Certificate and Retention Money* : In the case of contracts running for long period of time, it is customary for the contractor's firm to get 'on account' payments against the portion of contract completed. The amount received depends upon the extent of work certified by the technical assessor (surveyor or architect), i.e. on the surveyor's certificates, as these are called. Normally such payments are not received to the full extent of the work completed but a small percentage is held back as retention money, payable on completion of the contract. The retention money is a sort of safeguard available to the contractee in case the contractor is not able to fulfill one or more of the conditions laid down in the contract. The book-keeping entries involved on certification of work (with assumed figures) are as follows :

Dr. Personal Account, Contractee	Rs. 25,000	
Dr. Retention Money Account	Rs. 5,000	
Cr. Contract Account		Rs. 30,000

Alternatively, the Retention Money Account may be dispensed with and the contractee debited with the entire amount of work certified, the retention money withheld being represented by the debit balance of the Contractee Account after crediting it with cash received in full against the contract.

Dr. Personal Account, Contractee	Rs. 30,000	
Cr. Contract Account		Rs. 30,000
Dr. Cash Account	Rs. 25,000	
Cr. Personal Account, Contractee		Rs. 25,000

The amount certified may also be recorded as a memorandum entry and the contract credited with the full value only when the work is completed. In such a case, amounts received from time to time based on surveyor's certificates, do not pass through the contract account ; these are credited to the account of the contractee but in the Balance Sheet, the total amount received is shown on the assets side as a deduction from the cost of the contract.

(x) *Defective work* : Defective work will not evidently be paid for by the contractee but the cost of such defective work should be charged to the contract account. Sometimes, rectification of the defective work is required to be made at

the contractor's cost ; the cost of such rectification should also be charged to the contract account but shown separately

(xi) *Extra Works* : Sometimes when the work is in hand, the contractor is asked to do some extra work not provided for in the contract. An estimated cost with reasonable percentage of profit added to it is worked out and quoted to the contractee. Before undertaking such work, proper authority from the contractee indicating the specific quantum of work and the acceptance of the price quoted should be looked for and the contract suitably amended or a fresh contract entered into for the extra work

(xii) *Escalation clause* : Escalation clauses are often provided in contracts as safeguards against any likely changes in price or utilisation of material and labour. Such a clause in a contract would provide that in the event of a specified contingency happening, the contract price would be suitably enhanced. This clause is particularly necessary where the prices of certain raw materials are likely to rise, where labour rates are anticipated to increase, or where the quantity of material or labour time cannot be properly assessed or estimated unless the work has sufficiently advanced. There may also be a '*De-escalation or Reserve clause*' to provide for any future decrease in price etc. so that the benefit may be passed on to the contractee

(xiii) *Work-in-progress* : In contract accounts, the value of the work-in-progress consists of (a) the cost of work completed both certified and uncertified, (b) the cost of work not yet complete and (c) the amount of profit taken as credit. In the Balance Sheet, the work-in-progress is usually shown under two heads, viz. certified and uncertified. The cost of work completed and certified and the profit credited will appear under the head 'certified' work-in-progress, while the completed work not yet certified and the cost of labour, material and expenses of work which has not reached the stage of completion are shown under the head 'uncertified' work-in-progress.

(xiv) *Profit on incomplete contracts* : Many contracts take more than one financial accounting year to be completed. A problem arises whether profit on such a contract should be worked out only on its completion or whether some profits may be computed every year and the work-in-progress at the year-end which is to be carried over to the next financial year, valued at cost plus an element of profit. The conservative method is to value work-in-progress only at cost and no credit is taken for profit till it is actually earned. This method, however, results in wide fluctuations in the net profit of the concern from year to year. If several contracts are completed in a year, the profits will be high in that year while in the extreme cases in some years, when not a single contract is fully completed, the profit will be nil. Consensus is, therefore, to compute profit on partly completed contracts and take credit for a part of it in the accounts at the year-end. The manner of computation of the profit is largely dependent upon how far the contract has advanced i.e. the stage of completion it has reached, as discussed below :

- (a) *For contracts which have been taken up just in hand, or which have not far advanced, say up to one-fourth of the total contract, no profits need be credited to the Profit and Loss Account as it would be too*

early to foresee and estimate with a reasonable degree of accuracy, any profits on the small amount of work done.

- (b) In case of *contracts which have progressed* for quite some time, profit is computed as the difference between the value of the work certified (less a portion thereof to allow for contingencies, damages, penalty etc.) and its corresponding contract price. Even this amount of profit is, however, not taken in full to the Profit and Loss Account but a part thereof is withheld to allow for any anticipated future loss on the remaining portion of the contract. Conventionally, only one-third to two-thirds of the computed profit is credited to the Profit and Loss Account depending upon the stage of completion the contract has reached ; usually one third in case of completion of less than 50% and two-thirds when work completed is 50% or more. Sometimes, the credit for the profit is still less, proportionate deduction being made for the amount not received in cash from the contractee ; the amount of profit is further reduced in the ratio of cash received to the value of work certified.
- (c) When the *contract is almost complete*, method (iii) (shown in Example 7.2) is used. An estimated profit is computed by deducting from the contract price, the cost of work to date and the estimated cost yet to be incurred on the balance of work to be completed. The estimated profit is reduced in the manner illustrated, for transfer to Profit and Loss Account.

Various methods of computing profit on contracts are illustrated below :

EXAMPLE 7.2.

An expenditure of Rs. 1,94,000 has been incurred on a contract to the end of 31st March, 19×3. The value of work certified is Rs. 2,20,000. The cost of work done but not yet certified is Rs. 6,000. It is estimated that the contract will be completed by 30th June 19×3 and an additional expenditure of Rs. 40,000 will have to be incurred to complete the contract. The total estimated expenditure on the contract is to include a provision of 2½ per cent for contingencies. The contract price is Rs. 2,80,000 and Rs. 2,00,000 has been realised in cash up to 31st March, 19×3. Calculate the proportion of profit to be taken to the Profit and Loss Account as on 31st March, 19×3, under different methods.

(I. C. W. A., Inter)

ANSWER :

Value of work certified	Rs. 2,20,000
Cost of work uncertified	Rs. 6,000
Less expenditure incurred	Rs. 1,94,000

Profit (notional) Rs. 32,000

Method (i)

Profit to be credited to Profit & Loss Account

$$= \frac{2}{3} \times \text{Notional profit} \times \frac{\text{Cash received}}{\text{Work certified}} = \frac{2}{3} \times \text{Rs. } 32,000 \times \frac{2,00,000}{2,20,000} = \text{Rs. } 19,394$$

Method (ii)

Profit to be credited = Notional profit $\times \frac{\text{Work certified}}{\text{Total value of contract}}$

$$= \text{Rs. } 32,000 \times \frac{2,20,000}{2,80,000} = \text{Rs. } 25,143$$

Method (iii)

Value of total contract		Rs. 2,80,000
Less Expenditure incurred	Rs. 1,94,000	
Additional estimated expenditure	Rs. 40,000	
2½% contingencies on total expenditure	Rs. 6,000	
		Rs. 2,40,000
Estimated notional profit		Rs. 40,000
Profit to be credited	Estimated profit / $\frac{\text{Value of work certified}}{\text{Total value of contract}}$	
	Rs. 40,000 $\frac{2,20,000}{2,80,000}$	Rs. 31,428

This may be further scaled down by the ratio of cash received to work certified.
Thus, profit to be transferred to Profit & Loss Account.

$$\text{Rs. } 31,428 \times \frac{2,00,000}{2,20,000} = \text{Rs. } 28,570$$

Any loss arising in respect of the work completed to date should be transferred in full to the Profit and Loss Account by crediting the contract account. If further losses in the remaining portion of the work to be completed are anticipated, suitable provision for these should be made in the account.

The reasons for making a conservative provision for profit in the accounts are :

- (i) Until the work is certified, it cannot be taken as complete and no credit for profit should be taken.
- (ii) As the cash received is less than the value of work certified, full credit for profit would mean that even the unrealised profit may stand for distribution as dividends.
- (iii) Withholding a portion of the profit is based on the consideration that unforeseen contingencies and likely damages or losses would reduce the future profit.

The methods of presenting Contract Accounts are illustrated below :

EXAMPLE 7.3.

From the following particulars write up Contract Account No. 256, calculating and incorporating therein, the profit to be taken to the credit of the Profit and Loss Account for the year ended 31st March, 19aa.

	Rs.
Materials sent to site	1,70,698
Labour engaged at site	1,48,750
Cost of plant installed at site	30,000
Direct expenses including insurance of works	6,334
Establishment expenses	8,252
Materials returned to stores	1,098
Work certified	3,90,000
Cost of work not certified	9,000
Materials in hand on 31.3.19aa	3,766
Wages accrued due on 31.3.19aa	4,800
Direct expenses and insurance premium accrued, due on 31.3.19aa	480
Value of plant as revalued on 31.3.19aa	22,000
The contract price agreed upon with the contractee is Rs. 5,00,000. Payment of Rs. 3,60,000 has been received from the contractee.	(I.C.W.A., Inter)

ANSWER :

	Rs.	Rs.
(a) Materials sent to site	1,70,698	
Less materials returned to stores	1,098	
Less materials in hand	3,766	1,65,834
Labour engaged at site	1,48,750	
Add wages accrued	4,800	1,53,550
Direct expenses including amount accrued		6,814
Establishment expenses		8,252
Depreciation on plant (Rs. 30,000 – Rs. 22,000)		8,000
		<u>3,42,450</u>
Less cost of work not certified		9,000
		<u>3,33,450</u>
Cost of work certified		3,33,450
Value of work certified		3,90,000
		<u>56,550</u>
Profit*		56,550

Calculation of profit transferable to Profit and Loss Account :

$$\begin{aligned} \text{Proportion of cash received to work certified} &= \frac{\text{Rs. } 3,60,000}{\text{Rs. } 3,90,000} \\ \text{Profit transferred} &= \frac{\text{Rs. } 3,60,000}{\text{Rs. } 3,90,000} \times 23 \times \text{Rs. } 56,550 = \text{Rs. } 34,800 \text{ (Method i)} \\ \text{or} &= \frac{\text{Rs. } 3,90,000}{\text{Rs. } 5,00,000} \times \text{Rs. } 56,550 = \text{Rs. } 44,109 \text{ (Method ii)} \end{aligned}$$

CONTRACT ACCOUNT NO. 256

(Year ending 31.3.19aa)

	Rs.		Rs.
To Materials		By Work-in-Progress :	
Sent to site	Rs. 1,70,698	Certified	Rs. 3,90,000
Less Returns	Rs. 1,098	Uncertified	Rs. 9,000
	<u>1,69,600</u>		<u>3,99,000</u>
To Labour on site	Rs. 1,48,750	By Materials in hand	3,766
Add Wages accrued	Rs. 4,800	By Plant in site	22,000
	<u>1,53,550</u>		
To Direct Expenses	Rs. 6,334		
Add accrual	Rs. 480		
	<u>6,814</u>		
To Establishment expenses	8,252		
To Plant at site	30,000		
To Balance (c/d)	56,550		
	<u>Rs. 4,24,766</u>		<u>Rs. 4,24,766</u>
31st March, 19aa		31st March, 19aa	
To P. and L. Account	Rs. 44,109*	By Balance (b/d)	Rs. 56,550
To Balance c/d (Reserve)	Rs. 12,441		
	<u>Rs. 56,550</u>		<u>Rs. 56,550</u>

*Method (ii)

Note 1. The entries on the Assets side of the Balance Sheet as on 31st March, 19aa will be :

Assets	Rs.		
Work-in-progress certified	3,90,000		
Work-in-progress uncertified	9,000		
Plant on site	22,000		
Materials in hand	3,766		
	-----	Rs. 4,21,766	
Less Reserve		Rs. 12,441	
Less Cash received		Rs. 3,60,000	Rs. 52,325

Note 2. The Contract Account may be presented in another manner as follows :—

CONTRACT ACCOUNT No. 256

	Rs.		Rs.
To Materials	1,69,600	By Work-in-Progress	
To Wages	1,53,550	Certified	3,77,559
To Direct Expenses	6,814	Uncertified	9,000

			3,86,559
To Establishment Expenses	8,252	By Materials in hand	3,766
To Plant at site	30,000	By Plant at site	22,000
To Profit and Loss Account (Profit transferred)	44,109		
	-----		-----
	Rs. 4,12,325		Rs. 4,12,325
	-----		-----

Cost-Plus Contracts. Cost-plus contracts provide for the payment by the customer or the contractee, of the actual cost of manufacture or of rendering service plus a stipulated profit. The items of expenditure to be included in the actual cost are broadly agreed upon in advance, and the books and documents of the manufacturer are open to check and scrutiny by the customer or his representative. The profit to be added to the actual cost may be a fixed amount or it may be in the form of a suitable percentage on cost or on the capital employed. Cost-plus contracts are entered into when at the time of undertaking a work, it is not possible to estimate its cost with reasonable accuracy due to unstable conditions of material, labour, services, etc. When the work is spread over a long period of time, prices of materials, rates of labour, etc. are liable to fluctuate. In such cases, cost-plus contracts are advantageous both for the manufacturer and the customer as neither party stands to lose ; a fair price is offered to the customer and a reasonable profit accrues to the manufacturer.

Cost-plus contracts have the following *advantages* :

For the manufacturer

1. There is no risk of incurring any loss on the contract because all agreed costs are recovered.
2. It provides ready escalation clauses so that increase in cost of materials, labour, and other expenses are automatically adjusted and recovered and thus there are no bargaining difficulties.
3. The work of offering tenders and quotations is simplified and any errors and omissions made in the initial stages in the quotations are set right.

For the customer

1. In an uncertain market the customer is suitably fortified as he has to pay only a reasonable price.
2. Purchase risks are eliminated in so far as the purchase price is concerned.

The *disadvantages* of cost-plus contracts are :

For the manufacturer

1. Advantage which would have accrued due to favourable market, if any, for the product is lost. Even though the market price of the finished goods may go up, only the agreed price is recoverable as the cost-plus basis normally provides for fluctuations in costs but not in profits.
2. Profit usually being based as a percentage of cost, any efficient working which reduces costs, also reduces the profit.

For the customer

1. The final prices to be paid are uncertain with the result that the purchase budget cannot be properly set.
2. If the goods obtained on cost-plus basis are meant to be sold as such or after some processing, there will be, in the absence of a firm purchase price, difficulty in fixing sale prices and in offering quotations.
3. For any inefficiency on the part of the manufacturer, the customer has not only to bear the resultant high costs but has also to pay corresponding higher profits. The customer may, however, protect himself by the inclusion of a suitable clause in the contract indicating the upper limit of spoilage, defective work etc. that may be allowed.

Two main considerations which apply when cost-plus contracts are entered into are :

- (i) what should constitute the cost, and
- (ii) what would be the fair rate or amount of profit.

No clear-cut line can be laid down regarding the items of cost to be included or excluded from the cost-plus calculations because every business will have its own peculiarities and problems, each of which has to be treated on merit. It is, however, essential that there should be a clear understanding and a definite agreement between the contractor and the contractee with regard to the allowable items of cost. The following principles may be kept in view :

- (a) Where materials are purchased both for general use as well as for utilisation in the cost-plus contract, the price at which issues will be made to the contract account should be settled beforehand.
- (b) Imprudent purchases of materials at high rates are usually disallowed by the customer.
- (c) The materials to be used and the normal wastage and spoilage allowable should be mutually agreed upon.
- (d) Any windfalls and abnormal losses are not to be included in costs.

- (e) If purchased solely for the contract, costs of special plants, less their scrap values, are chargeable to the cost of the contract. When plants are used partly for the contract and partly for general purposes, the rate of depreciation chargeable to the cost of the contract should be laid down.
- (f) The trades, grades and rates of pay of the various operatives employed for the contract work and the method of remunerating them are specifically laid down. Overtime payments will normally be not allowed unless ordered by the customer.
- (g) Interest on borrowed money, donations, subscriptions, and notional costs such as rent of owned building are usually not included in costs.

The second problem, viz. the determination of a reasonable profit presents considerable difficulty. The agreed profit, whether calculated as a percentage of cost or as a fixed amount for an order or a contract, should be such as to allow a fair return on the capital employed for the contract.

Economic Batch Quantity. A batch of production may consist of one single unit of a product when it is known as line production. Most batches of production would, however, consist of a larger number of units. If the total order for a period for an item be 10,000 units, the entire order may be manufactured in one lot of 10,000 units or it may for convenience in manufacture, be broken up into smaller batches, e.g. in two batches of 5,000 units each, four batches of 2,500 units each, ten batches of 1,000 units each, and so forth.

The concept of economic batch quantity which is similar to economic ordering quantity (see Page 25) arises basically from the fact that production costs consist of two elements viz. *set-up* (or *preparation*) cost and *carrying cost*. With the increase in the batch quantity, there is an increase in the carrying cost but the set up cost per unit of product is reduced; the position is reversed when the batch quantity is reduced. Thus, there is one particular batch size which will involve minimum cost and will, therefore, maximise profits. This is the *economic* or *optimum batch quantity*.

Set-up cost of tools and machines is a fixed amount which is incurred for a batch of production irrespective of the size of that particular batch. Set-up cost varies directly with the number of batches or with the batch frequency, as batches become more frequent the total set up cost increases. In other words, for a given production during a period, the total set-up costs increase with a reduction in the number of units manufactured in a batch.

Some other costs which increase with increase in the batch frequency and which, therefore, should be taken along with set-up cost for the purpose of determination of the economic batch quantity arise due to the following:

- (a) Time lost during change over from one batch to another
- (b) Loss of skill and speed of the worker due to too frequent changes
- (c) Closer supervision necessary at the time of each set-up
- (d) Material wastage due to change of machine feed
- (e) Other costs related to short runs.

On the other hand, carrying cost which depends upon several variable

factors such as storage and obsolescence of inventory, interest on locked up capital, depreciation, machine breakdowns, and sub-standard and defective work, varies directly with the size of a batch, i.e. with the batch quantity. With the increase in the number of units produced in a batch, or in other words, with the decrease in batch frequency, the cost of carrying the inventory rises.

Like the economic ordering quantity, economic batch quantity may be determined with the help of tables, mathematical formulae, or graphs. A table is given below which shows the set-up and carrying costs of production of 10,000 units per year of a product with different batch frequencies or batch sizes, the set-up cost and the carrying cost being assumed to be Rs. 200 per batch and Re. 0.10 per unit respectively.

Production :

Total production units	10 000	10,000	10,000	10,000	10,000
Batch quantity (units)	10,000	6,000	4,000	2,000	1,000
Batch frequency (number of batches per year)	1	1.67	2.5	5	10
Maximum inventory	10,000	6,000	4,000	2,000	1,000
Average inventory (half of maximum inventory)	5,000	3,000	2,000	2,000	500

Costs :

Set-up cost					
Rs. 200 per batch	Rs. 200	Rs. 333	Rs. 500	Rs. 1,000	Rs. 2,000
Carrying cost					
Re. 0.10 per unit	Rs. 500	Rs. 300	Rs. 200	Rs. 100	Rs. 50
Total cost	Rs. 700	Rs. 633	Rs. 700	Rs. 1,100	Rs. 2,050

The minimum cost as seen from the table, is about Rs. 633 for a batch consisting of approximately 6,000 units.

There are several formulae developed for determining the economic batch quantity. A simple formula is,

$$Q = \sqrt{\frac{2 \times U \times S}{C}}$$

Where,

Q = Quantity or units of products in the economic batch

U = Total number of units to be produced in a year

S = Set-up cost per batch

C = Carrying cost per unit of production.

Taking the figures from the table above, economic batch quantity.

$$Q = \sqrt{\frac{2 \times 10,000 \times 200}{0.10}} = 6,324$$

If the rate of interest and the cost of production per unit be given, the following formula may be adopted for determining the economic batch quantity,

$$Q = \sqrt{\frac{2 \times U \times S}{I \times C_1}}$$

Where, I = rate of interest per year, and C_1 = cost of manufacture per unit.

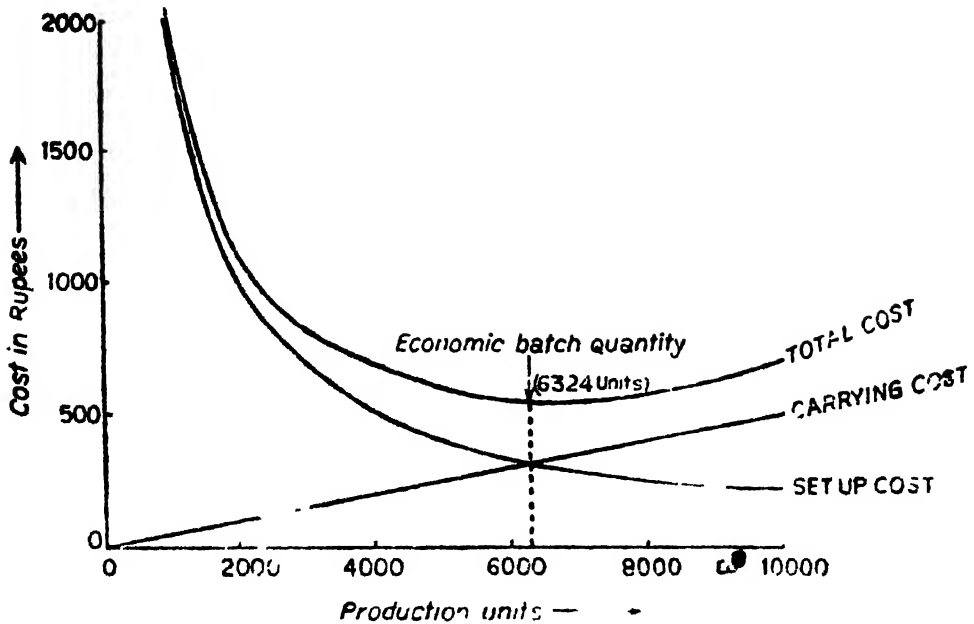


Fig 7.10 Economic Batch Quantity

A graphic representation of the economic batch quantity is illustrated in Fig. 7.10. The formula and the graph may be compared with those for the economic ordering quantity

EXAMPLE 7.4

Messrs KOBLO Bearings Ltd. is committed to supply 24,000 bearings per annum to Messrs Deluxe Fans on a steady daily basis. It is estimated that it costs 10 paise as inventory holding cost per bearing per month and that the set-up cost per run of bearing manufacture is Rs. 324.

- (i) What should be the optimum run size for bearing manufacture?
- (ii) What would be the interval between two consecutive optimum runs?
- (iii) Find out the minimum inventory cost. (I.C.W. 4 Final)

ANSWER :

$$(i) \text{ Economic batch or run size } = \sqrt{\frac{2 \times \text{Set-up cost} \times \text{Annual production}}{\text{Annual holding cost per unit}}}$$

$$= \sqrt{\frac{2 \times 324 \times 24,000}{1.2}} = 3,600 \text{ units.}$$

$$(ii) \text{ Number of set-up per annum } = \frac{\text{Annual production}}{\text{Economic run size}} = \frac{24,000}{3,600} = \frac{20}{3}$$

$$\text{Interval between two consecutive optimum runs} = 12 \div \frac{20}{3} = 1.8 \text{ months}$$

$$(iii) \text{ Minimum inventory cost per year} = \frac{24,000}{3,600} \times 324 + \frac{3,600}{2} \times 1.2 = \text{Rs. } 4,320$$

The economic batch quantity concept is useful for formulating production policies, particularly where a large number of components are manufactured and kept in stock for some time before they are drawn and used for assembly work. It has, however, certain limitations and in practice, too rigid an adherence to the economic batch quantity may be neither possible nor advisable. Some of these limitations are :

- (a) Reduction in batch quantity may not necessarily increase set-up cost, because ;
 - (i) frequent setting up results in more efficiency leading to reduced setting time and reduced tool wear.
 - (ii) with the increase in the batch quantity, there is likely to be a reduction in the number of breakdowns.
- (b) As set-up costs are assumed to be constant, the possibility of cutting them down is lost sight of and no efforts are made to reduce costs.
- (c) As each element of cost behaves in a different manner, it is not necessary that the optimum batch will always result in minimum cost. An abnormal change in the cost of the elements may upset the calculations.

Other Variants of Job Costing System

Batch Costing or Assembly Cost System :

This is a special type of job costing which is applied in companies manufacturing in batches, a variety of components or other units of production. The products are usually kept in stock for sale to customers on demand. For example, in a clothing factory, garments are manufactured in suitable batches and kept in stock for sale and it will not be worthwhile maintaining cost records for each garment made against customer's specifications. Components, a number of which are required for assembling into a product, are manufactured in convenient and economic batches and are either kept in stock for subsequent use for assembly into complete products against orders received, or are issued direct to assembly orders for immediate assembly. Unless production is standardised and the components are manufactured for stock, each batch of production would be normally different from the rest.

Except for the difference that in batch costing, a batch, instead of a job, constitutes the cost unit for which costs are compiled, the procedure for batch costing is similar to the one adopted for job costing. Separate job cost sheets are maintained for each batch of components manufactured and for the assembly of finished products. When products are stocked for eventual sale, a higher degree of control is required to be exercised over the finished stock. Normal principles of stock control are used, e.g. a production order is issued only when the stock of finished goods reaches the ordering level.

Class Cost System : This system is applicable in the case of concerns which manufacture a large variety of products, many of which are similar. According to their similarity in nature, the varieties can be grouped into a smaller number of types or classes. Instead of separate job cost sheets for each product, costs of similar products falling under a class may be compiled on a Class Cost Sheet. For

example, if a foundry producing 500 different types of castings in a period finds that tracing the costs to individual castings is too meticulous and expensive a procedure, job costs may be compiled by classes ; a class may consist of say, 20 or 25 homogeneous types of casting. Even if the castings in a class are not homogeneous, costs may be traced to the castings in the class on a weightage or point basis. Though the class-cost system reduces clerical work to a large extent, it leads to unreliable costs if the products within a class are not quite homogeneous.

Multiple Job Order Cost System : This is opposite to the class cost system. In multiple job order cost system, a large job which runs for a fairly long period is split up into its several individual components. Instead of one job cost sheet for the entire job, separate job cost sheets are maintained for each individual component. For example, the production order for a product which consists of several components may be sub-divided and separate production or job orders may be issued for each component. A suitable index or code may be maintained to link the job order numbers of the components with the parent job order number for the final product. As costs in this method are compiled for each component, more effective control is possible than in the case where the costs of all the components are lumped up in one cost sheet. This system is also known as *Composite Cost system*.

PROCESS COSTING

Process costing is the type of costing applied in industries where there is continuous or mass production. The necessity for compilation of the costs of a process or a department for a given period, as distinct from the costs of a whole job or a specific batch of production units, has given rise to the concept of process cost accounting. There are many industries engaged in continuous processing in which the end products are the results of a number of operations performed in sequence. In such industries, it is necessary to apply process costing. Even in a jobbing factory which mainly adopts job costing, the cost of a particular department or operation is often required to be worked out, necessitating the application of process cost methods.

Process Plants. Process costing is suitable for a large number of mining, manufacturing and public utility industries like mines and quarries, cotton, wool and jute textiles, chemicals, soapmaking, paper, plastics, distillation processes, e.g. alcohol, tanning, oil refining, screws, bolts and nuts, canning, food products, dairy, and electricity and gas undertakings. Industries applying process costing may be broadly classified as follows :—

- (i) **Single product plants** like those producing electric power, steam, gas, water, ice, bread, steel, cement, paper, rubber, etc. where the entire plant or factory manufactures, through one or more processes, one single product, or the various departments of the factory are responsible for the manufacture of one product each.
- (ii) **Factories** which manufacture different product in one and the same process but each product has a separate run, one at a time, e.g. bakeries, canning plants, flour mills, etc. Costs are worked out separately for each such run.

- (iii) Units in which different products are simultaneously produced from the same process, e.g. foundries, laundries etc. Costs of the various products are computed on a weighted average basis, each product being given a weight factor according to its importance.
- (iv) Plants in which a particular standard or repetitive operation or process is carried out in one department or cost centre, e.g. in mass production of automobile parts, electrical and mechanical equipments, screws, nuts and bolts, oil refineries etc.

Process Costing and Job Costing Compared. A comparison of the basic principles of process costing with those of job costing, given below, will assist in appreciating process costing procedures.

Job Costing

1. Production is by specific orders.
2. Costs are determined by jobs or batches of products.
3. The various jobs are separate and independent of each other.
4. Unit cost of a job is calculated by dividing the total costs incurred into the units produced in the lot or batch.
5. Costs are calculated when a job is completed.
6. There may or may not be any work-in-process at the beginning or end of an accounting period.
7. There are usually no transfers from one job to another unless it is necessary to transfer surplus work or excess production.
8. As each product unit is different and production is not continuous, more managerial attention is needed if proper control is to be exercised.

Process Costing

1. Production is in continuous flow, the products being homogeneous.
2. Costs are compiled on time basis, i.e. for production for a given accounting period, for each process or department.
3. Being manufactured in a continuous flow, products lose their individual entity.
4. The unit cost of a process, which is computed by dividing the total cost for the period into the output of the process during that period (after adjustment of the opening and closing work-in-process), is an average cost for the period.
5. Costs are calculated at the end of the cost period.
6. Production being continuous there is usually some work-in-process at the beginning as well as at the end of the accounting period.
7. As a product moves from one process to another, transfers of costs from process to process are made.
8. Process production is standardised and is more stable. Hence, control of process activities is comparatively easy.

Combination of Job Order Costing and Process Costing. In certain cases, job costing and process costing are so interwoven that both the types of costing may be simultaneously in use. Such a situation may arise in the following cases —

- (i) Separate departments or divisions of an undertaking may be engaged in the manufacture of different products so that job costing may be in use for some of the products and process costing for the rest. A concern may, for instance, adopt process costing for its electro-plating and foundry sections, while job costing may be in use for the other producing departments such as the machine shop.
- (ii) In some processing plants, e.g. bakeries, canning units etc., production is intermittent and the processing of the products is done in batches or successive runs. While process costing is used for compiling the cost of

- the process, each batch of production may be represented by a production order, the cost of which is compiled as job order cost.
- (iii) There are certain products which are processed in bulk in the earlier stages of manufacture and it is only in the later stages that they can be recognised as identifiable products. In such cases, for one and the same product, the system applied first is process costing which is then changed to job costing for subsequent operations. Some engineering concerns manufacture steel ingots, blooms, and billets which are further machined into various types and ranges of engineering products. While the cost of steel is determined under the process cost system, job costing is used for determining the costs of individual products.
 - (iv) Sometimes the foregoing process is reversed. Job costing is applied for the initial stages and process costing for the later process or processes of manufacture. This happens in industries which are mainly process industries where process costs are applied for the final products, but the components, parts, or fixtures are costed individually under the job cost system.

Principles of Process Cost Accounting. The basic principles involved in the accounting of process costs are simple and are similar to those adopted for the job costing system. The first step is for the cost accountant to familiarise himself with the complete layout or flow chart of the production processes. A few simple process flow charts have been shown in Fig. 7.11. As the emphasis is on departments or processes rather than on individual products, fixation of suitable cost centres for the purpose of determination of process costs should be carefully done. Costs are classified into labour, material, and overhead and are collected for each cost centre for each accounting period. The period, which may be a day, week, or month is determined by the production cycle or by the extent of control to be exercised. The output of the process or department (i.e. the cost centre) is determined in terms of physical units like numbers, tonnes, kilograms, metres, litres, etc. and the total cost for the period divided by the units of production for the period—taking into consideration work-in-process, lost units etc.—gives the average unit cost of the process or department for the period concerned.

The following are the special features of process cost accounting :

Process Departments : The factory is divided into processes or departments which carry out certain operations, each of which constitutes a definite stage in the routine of manufacture. The material passes through one or more such processes or departments before the production cycle is completed and the finished product is obtained. Costs accounting follows this pattern of organisation and an account is kept for each process or department. Costs are collected and allocated by process order numbers in the same manner as costs of jobs are compiled for production order numbers.

Production Schedules : Production or Process Schedules are used in process industries in the same way as production orders are used in jobbing factories, but they function in a slightly different manner. The operations in the various processes are, more or less, standardised and are already well-known to all concerned in the manufacturing unit, as a matter of routine. These are also not subject to change for different batches of production. A production schedule

does not, therefore, indicate the operations in details. It simply shows the quantity of production (the quantity to be produced) during a specified period and the requirement of the various raw materials to meet this production. To the cost accountant, the flow of production given in the schedule provides information regarding the extent of cost incurred and the point of its incidence.

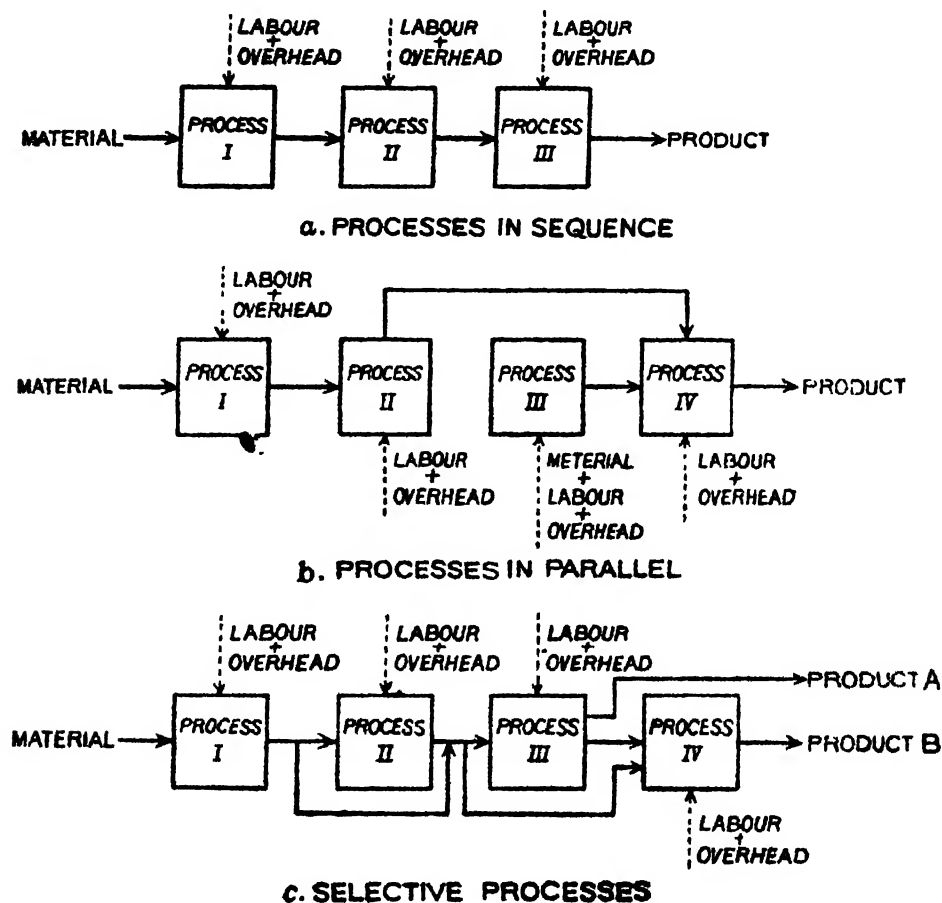


Fig. 7.11. Process Flow Chart

Process costs are compiled under the various cost elements as follows :--

Materials : (i) Ordinarily, there is no distinction between direct or indirect material, almost all materials being charged to the processes or departments. Materials not directly chargeable to process and materials consumed in service departments are, however, distinguished as indirect material and booked against Standing Order Numbers in the usual manner.

(ii) Issues are made on materials requisitions or on bills of materials, where materials requisitions are dispensed with. Issues may be accounted for under one of the following methods :

(a) In a continuous process, where process materials are drawn in bulk in a steady flow, it is difficult to properly record the raw materials consumed as distinct from the materials issued. Materials consumed out of the bulk supply during an accounting period are recorded in consumption statements or reports. These statements indicate the opening balances,

issues, consumption, and closing balances of all process materials for each accounting period. The consumption is recorded, either (i) by taking actual stock of opening and closing balances of stores drawn at the beginning and end of the period, or (ii) by technical assessment by applying to the finished product, proper proportions of raw materials it should normally contain. We know, for example, that when two or more chemicals (i.e. the raw materials) combine to form another chemical (i.e. the product), they follow the law of definite proportions so that if the quantity of the product is given, the quantity of the raw materials can easily be worked back. The quantity of material consumption may also be computed as a ratio of the output or input. For example if there is a normal wastage of 10% of input in a process, 100 units of raw materials may be drawn for every 90 units of output.

- (b) As in job costing, all materials drawn on materials requisitions are taken as finally issued from stock but instead of charging to specific jobs, all requisitions for a period are charged to the process or department. This method is based on the premise that materials once issued are to be taken as consumed.

Assuming that there are three processes, the journal entries for charging material costs would be :

Dr. Work-in-Process Account – Process A (Mixing Deptt.)
 Dr. Work-in-Process Account – Process B (Refining Deptt.)
 Dr. Work-in-Process Account – Process C (Finishing Deptt.)
 Cr. Stores Control Account

Labour : (i) Like materials, there is not much of a distinction between direct and indirect labour. Indirect labour pertaining to service departments should, however, be listed.

(ii) Payrolls are prepared according to departments or processes so that job cards are dispensed with. In this respect and also in regard to apportionment of overhead discussed below, process costing involves one step less in accounting than job costing.

(iii) Wages of workers who look after more than one process are allocated to each process on the basis of time bookings. The bookings may be done on daily (or monthly) time tickets, and so job time cards as in job costing system are not required. Idle time, if any, should be segregated and booked to overhead expenses under a separate Standing Order Number.

The journal entries for booking wages cost to processes are :

Dr. Work-in-Process Account – Process A (Mixing Deptt.)
 Dr. Work-in-Process Account – Process B (Refining Deptt.)
 Dr. Work-in-Process Account – Process C (Finishing Deptt.)
 Cr. Wages Control Account

Direct expenses : Items of expenditure directly traceable to a process are charged to the Process Account concerned.

Manufacturing overhead : (i) Most of the expenses would be charged direct to the process or department.

(ii) The expenditure which is not charged direct is apportioned on the basis of recovery rates as in the case of job costing. Overhead rates are required to be worked out only for each cost centre (process or department) and not for levy on

specific jobs or orders. Sometimes, variable expenses for the process are kept separate and charged direct while fixed overhead is charged on the basis of overhead rates.

(iii) As production is fairly stable, the pre-determined overhead rate for recovery tends to be more or less the same as the actual rate and sometimes recovery is made on the basis of actual rates unlike in the case of jobs where production not being uniform, pre-determined rates are necessary to smooth out fluctuations. Pre-determined overhead rates will, however, be applicable under the following circumstances :—

- (a) Where production is not stable or is intermittent.
- (b) Where there are seasonal variations of business.
- (c) Where factory overhead constitutes a fairly significant portion of the cost
- (d) When the process yields joint products.

The journal entries are :

Dr. Work-in-Process Account—Process A (Mixing Deptt.)
 Dr. Work-in-Process Account—Process B (Refining Deptt.)
 Dr. Work-in-Process Account—Process C (Finishing Deptt.)
 Cr. Factory Overhead Control Account

Production Cost Report or Process Cost Sheet : This is the counterpart of job cost sheet used in job costing systems to record the costs. Production cost reports

PROCESS COST SHEET					
	Process 1		Process 2		Total
	Total Cost Rs.	Cost per unit Rs.	Total Cost Rs.	Cost per unit Rs.	Cost for all processes Rs.
1. <i>Cost of Production</i>					
Cost from previous process					
Cost added in process :					
Material					
Factory overhead					
Cost in Process					
Total Process Cost					
2. <i>Units of Production</i>					
From earlier processes completed and transferred					
Current input					
Total Units completed					
Balance in process :					
Material (% completion)					
Labour (% completion)					
Total Equivalent Units					
3. <i>Cost per unit</i>					
Completed					
Work-in-process					

Fig. 7.12. Process Cost Sheet

Note : Standard costs may also be indicated against the output and the variances recorded.
 (Loss of units has been ignored.)

in process costing (see Fig. 7.12) are prepared for a period and not for each process order. These are comparatively more detailed than job cost sheets because, besides the elements of costs, summaries by each department are given.

Advantages and Limitations of Process Costing. Process costing has the following *advantages* :—

- (i) Process costs may be determined periodically at short intervals. When predetermined overhead rates are in use, it may be possible to complete unit costs weekly or even daily. This is not always so under the job costing system, particularly when jobs run for long periods and there are no significant units of completed production during the various accounting periods, falling between the total period of run of the jobs
- (ii) It involves less efforts and less clerical expenses as the accounting method is simpler than that in job costing.
- (iii) Detailed costs, budgeted as well as actual, are made available for each process, operation, or department. Thus, managerial control is possible by evaluating the performance of each process etc.
- (iv) Allocation of overhead to departments and processes can be made fairly accurately on definite bases.
- (v) Since the material consumption and the various operations are more or less standardised, more accurate cost estimates are available for price quotations.
- (vi) It is easier to set effective and fairly stable standards in case of mass production or continuous repetitive production. Process costing situations are, therefore, more adaptable for installing standard costing procedures.

The *limitations and weaknesses* of process costing systems are as follows :—

- (i) Being only average costs for the accounting period, process costs cannot be considered to be very accurate for the purpose of detailed analysis, evaluation, and control of individual performance efficiency on a day-to-day basis.
- (ii) Costs obtained at the end of the accounting period are only historical and are not of much use for effective control unless standard process costs are used. This is, no doubt, true in respect of all other historical systems but the nature of process accounting with its departmental divisions makes this disadvantage more prominent.
- (iii) When different products come out of one and the same process, the common costs are prorated to the various products. Such costs of individual products are not reliable as they may, at best, be taken to be only approximations.
- (iv) For the purpose of calculation of unit costs of continuous processes, work-in-process is required to be determined at the end of an accounting period. This is done mostly on estimated basis which introduces further inaccuracies in costs.

Process Costing Procedures. The procedure for costing applicable to processes or departments will vary in details according to the requirements of production methods. The various situations and problems envisaged and the

methods of calculation of costs in respect of each of the situations have been discussed under the following heads :

1. Single process production.
2. More than one process involved ; output of one process transferred in full to the subsequent process.
3. Output of a process partly transferred to the next process and partly retained in stock.
4. Process consisting of opening and closing stock, fully completed.
5. Normal and abnormal losses occurring in a process but there is no closing stock or the closing stock is fully complete.
6. Process consisting of partially completed closing stock.
7. Normal loss or abnormal loss involved—closing stock partially complete.
8. Process consisting of partially completed opening stock.
9. Normal and/or abnormal losses and both opening and closing work-in-processes.

1. *Single Process production* : Here, only one process is involved which produces one product, such as in moulding, stamping of parts, simple assemblies, polishing, varnishing, or painting of components or products. The aggregate cost of materials, labour, and overhead incurred in an accounting period is divided into the units of output in that period in order to arrive at the cost per unit, as illustrated below. It is assumed that there is no incomplete production (work-in-process) at the end of the period and that the number of units coming out of the process and transferred to the finished goods is the same as the number of units put into the process at the start.

PROCESS A

Period : June 19xx	Production Cost per unit	20,000 units, Total cost
	Rs.	Rs.
Material	1.00	20,000
Labour	0.50	10,000
Overhead	0.30	6,000
	<hr/> Rs. 1.80	<hr/> Rs. 36,000

A Process Account is opened in the General Ledger to which the costs of material, wages, and factory overhead are transferred at the end of the accounting period. Separate process accounts are opened for each process. The journal entries made to record the transactions at the end of the period are :

Dr. Process Account	Rs. 36,000	
Cr. Stores Control Account		Rs. 20,000
Cr. Wages Control Account		Rs. 10,000
Cr. Factory Overhead Control Account		Rs. 6,000
(Summary of total cost of the process for the period)		
Dr. Finished Goods Control Account	Rs. 36,000	
Cr. Process Account		Rs. 36,000
(Transfer of cost of process to finished goods)		

2. *More than one process is involved, the output of one process being completely transferred to the next process* : If the entire output of 20,000 units of process A in the previous example is transferred to process B, the cost per unit transferred will be Rs. 1.80 and the process accounts will be as shown on the following page.

Process A				
Period : June 19xx				
	Rs.	Cost per unit Rs.		Units
Material	20,000	1 00	Transferred to Process B	20,000
Labour	10,000	0 50		
Fy. Overhead	6,000	0.30		
	36,000	1 80		20,000
				36,000

Process B			
	Units	Cost per unit Rs	Rs.
Material from process A	20,000	1 80	36,000
Labour			5,000
Overhead			4,000
			Rs. 45,000

The journal entries at the end of the month will be as follows :—

Dr. Process A Account	Rs 36,000	
Dr. Process B Account	Rs 9,000	
Cr. Stores Control Account		Rs 20,000
Cr. Wages Control Account		Rs. 15,000
Cr. Factory Overhead Control Account		Rs. 10,000
(Summary of cost of process for the month)		
Dr. Process B Account	Rs 36,000	
Cr. Process A Account		Rs 36,000
(Transfer of cost from Process A to Process B)		
Dr. Finished Goods Control Account	Rs 45,000	
Cr. Process B Account		Rs. 45,000
(Transfer to finished goods)		

As will be seen from the above entries, separate control accounts are opened for each process. If the number of processes is large, a single process account is opened and subsidiary details for individual processes are maintained separately. In order to have effective control, work-in-process accounts may be maintained by elements of costs, i.e. separate Materials-in-process, Wages-in-process and Factory Overhead-in-process accounts may be opened to record the three elements of costs.

When only a part of the output of a process is transferred to another process, the total cost of the transferring process is apportioned between the units transferred and the units in stock, on the basis of cost per unit. The details of units of input and output and the units in process are obtained from the entries made in a form known as Process Production Report (see Fig. 7.13).

Production (Quantitative) Report	
Department X	Period : June 19xx
Total input into process	25,100
Completed and transferred to department Y	20,000
Work-in-process	5,000
Loss in process	100
	25,100

Fig. 7.13 Quantitative Production Report

3. *Output of a process partly transferred to the next process and partly retained in stock* : Assuming that 5,000 units of the output of Process A remain in stock and the balance is transferred to Process B, the position will be as follows :

Period : June 19xx

	Units	Rs.			Rs.
Material	20,000	20,000	Transferred to Process B Stock (c/f)	15,000	27,000
Labour		10,000		5,000	9,000
Overhead		6,000			
	20,000	Rs. 36,000		20,000	Rs. 36,000

EXAMPLE 7.5.

From the following details extracted from the costing records of an oil mill for a year ended 31st March, you are required to prepare the process cost accounts of (a) Groundnut Crushing Process ; (b) Refining Process ; and (c) Finishing Process including casking, and determine the cost per tonne of each process and the total cost per tonne of finished oil.

Purchase of 5,000 tonnes of groundnut - Rs. 48,00,000

	Crushing Plant Rs.	Refining Plant Rs.	Finishing Plant Rs.
Wages	25,000	10,000	15,000
Power	6,000	3,600	2,400
Sundry Materials	1,400	20,000	—
Repairs to Plant & Machinery	2,800	3,350	1,400
Steam	6,000	5,200	4,500
Factory Overheads	13,200	6,600	2,100
Cost of Casks	—	—	59,600

3,000 tonnes of crude oil were produced ; 2,500 tonnes of oil were produced by the refining process ; and 2,480 tonnes of refined oil were finished for delivery.

Groundnut shells sold—Rs. 400 ; 1,750 tonnes of groundnut residue sold—Rs. 11,000 ; loss in weight in crushing—250 tonnes ; 450 tonnes of by-products obtained from Refining Process—Rs. 16,750.

(I. C. W. A., Inter)

ANSWER :

Groundnut Crushing Process

	Tonnes	Rs.		Tonnes	Rs.
Groundnut	5,000	48,00,000	Crudeoil (c/o)	3,000	48,43,000
Wages		25,000	Groundnut residue	1,750	11,000
Power		6,000	Groundnut shells		400
Sundry materials		1,400	Process loss	250	—
Repairs to Plant & Machinery		2,800			
Steam		6,000			
Factory Overheads		13,200			
	5,000	48,54,400		5,000	48,54,400

Cost per tonne of crude oil = Rs. 1,614.33

Refining Process

	Tonnes	Rs.		Tonnes	Rs.
Crude oil (b/f)	3,000	48,43,000	Refined oil (c/o)	2,500	48,75,000
Wages		10,000	By-products	450	16,750
Power		3,600	Process loss	50	—
Sundry materials		20,000			
Repairs to Plant & Machinery		3,350			
Steam		5,200			
Factory Overheads		6,600			
	3,000	48,91,750		3,000	48,91,750

Cost per tonne of refined oil = Rs. 1,950

Finishing Process

	Tonnes	Rs.		Tonnes	Rs.
Refined oil (b/f)	2,500	48,75,000	Finished Oil	2,480	49,60,000
Wages		15,000	Process loss	20	—
Power		2,400			
Repairs to Plant & Machinery		1,400			
Steam		4,500			
Factory Overheads		2,100			
Cost of casks		59,600			
	2,500	49,60,000		2,500	49,60,000

Cost per tonne of finished oil (including casking) = Rs. 2,000

4. *Process consisting of opening and closing stock, fully completed* : This is similar to the position obtaining in situation 3 above. The cost per unit of the process is obtained by dividing the total cost, inclusive of the cost of opening stock, into the total units of output. The transfer made to the other processes and the units remaining in stock are priced at this unit rate.

Process A

Period : July 19XX

	Units	Rs.		Units	Rs.
Stock (b/f)	5,000	9,000	Transferred to Process B Stock (c/f)	25,000	50,000
Material	30,000	40,000		10,000	20,000
Labour		12,000			
Overhead		9,000			
	35,000	Rs. 70,000		35,000	Rs. 70,000

$$\text{Unit Cost} = \frac{\text{Rs. 70,000}}{35,000} = \text{Rs. 2}$$

The units transferred to Process B and the units left in stock are costed at the rate of Rs. 2 per unit.

Before proceeding with the study of the other situations, we bring in at this stage, the concept of equivalent units and the procedure for treatment of losses in processes.

Equivalent or Effective Units. Partially completed stock, whether at the beginning or at the end of a period, creates complications in the computation of unit cost of the process. The units of unfinished work are in different stages of completion so that, unlike finished work, they cannot be taken as full units for the purpose of calculation of unit costs. The unfinished units should be expressed in terms of a common denominator in relation to the finished units. For example, 200 partly finished units on which 25% of the work has been completed are equivalent to 50 fully completed units. In order to distinguish them from the complete units, the incomplete units so computed in terms of complete units are known as *Equivalent* or *effective units* or *equivalent production units*. It should be noted that equivalent units are not physical units but they are only abstract units utilized for facilitating calculation of product costs and of performance.

Let us consider the following example :

Process A

	Units	Rs.		Units	Completion	Rs.
Material	40,000	50,000	Transferred to Process B Work-in-process	30,000	100%	
Labour		10,000		10,000	50%	
Overhead		10,000				
	40,000	Rs. 70,000		40,000		Rs. 70,000

The calculation of the effective units and the cost of output transferred to Process B will be worked out as follows :—

- Step 1. Consider the physical flow of production—the units of input and output. Here, production consists of 30,000 units transferred to Process B and 10,000 units of closing work-in-process. The total output agrees with the total input of 40,000 units.
- Step 2. Convert the production into equivalent or effective units :
- | | |
|--|----------|
| Completed units | – 30,000 |
| Work-in-process units – 10,000 at 50% completion | 5,000 |
| Effective units | – 35,000 |
- Step 3. Find the total cost of material, labour and overhead :
- Here, Rs. 70,000
- Step 4. Determine the cost of each equivalent or effective unit :
- | | |
|-------------------------|---------------------------|
| Cost per effective unit | Rs. 70,000/35,000 = Rs. 2 |
|-------------------------|---------------------------|
- Step 5. Determine the cost of production and cost of work-in-process :
- | | | |
|--------------------------------|---------------------|------------|
| Cost of production transferred | 30,000 × Rs. 2 | Rs. 60,000 |
| Cost of work-in-process | 10,000 × 50% × Rs 2 | Rs. 10,000 |
- Rs *70,000

*This agrees with the total input cost.

In practice, it may be necessary to work out separate equivalent units and unit process cost for each element of cost separately because material, labour and overhead may be in different stages of completion in the work-in-process inventory. All materials are usually issued and put into the process in the beginning itself and it is seldom that materials, unlike labour and overheads, are added gradually or in stages during the process. In the former case, therefore, the closing work-in-process should be taken as 100% complete in so far as the materials element is concerned irrespective of the fact that it may be in various stages of completion with regard to labour and overhead. For materials added at the end of the process, the percentage of completion will be zero.

In most process industries, all materials are put in the first process. Additional material may, however, be required to be put in subsequent processes. Depending upon the nature of the process, the additional material may be of two types, each having a different effect on the units and the unit process cost.

Type 1. The added material becomes a part of the final product but it does not increase the number of final units. Additional parts added in the assembly of automobiles and starch, bleaching material, dyes etc. added in the weaving, dyeing and finishing plants in the textile industry are examples of this type of material. The cost of the additional material increases the cost of the process and since there is no increase in the final units, the unit cost of the process is increased.

Type 2. The added material increases the number of final units. For example, chemicals or water added in a chemical process may increase the units of the mixture, thereby increasing the cost of the process and effecting a change in the unit cost since the cost is spread over a greater number of units.

In case of materials of type 2, the equivalent units should, therefore, be computed taking into account the units introduced in the current process. See Example 7.7.

Process Losses—Accounting of Lost Units. In many processes, the physical quantity of output is found to be less than that of the input, the difference being attributable to wastage, spoilage, shrinkage, evaporation etc., occurring in course

of manufacture. In order to compute correct costs per unit, the units entering a process must be reconciled with the output coming out of the process, and the lost units, as they are called, must be analysed to determine the factors leading to the loss. Units may be lost at the beginning of a process, during a process, or at the end of a process. If a product passes through several processes, the lost units will have an effect not only on the unit cost of the process in which they arise but also on the costs of the subsequent processes and on the cumulative unit cost of the final output

The treatment of normal spoilage costs in process accounts depends upon the stage at which the spoilage (rejection or loss) is assumed to occur. When normal spoilage occurs at the beginning of a process or during it, it is assumed that the lost units were never started in the process. In the computation of equivalent units, the normal spoilage units are ignored with the result that the cost of spoilage is charged to the production units completed and to abnormal spoilage, if any, as well as to the closing work-in-process. If the normal spoilage occurs at the end of a process, as is more common, the spoiled units are taken into account for computing equivalent units so that the cost of normal spoilage is charged only to the good units produced as well as to abnormal spoilage, if any, but no amount is charged to the closing work-in-process. The usual practice is to determine the cost of normal spoilage separately and add it back to the cost of good units produced.

Assuming that out of 1,100 units valued at Rs. 1,100 introduced in a process, 600 units were completed, 100 units were spoiled (normal, there being no abnormal spoilage) and 400 units were in the incomplete stage (only 50% complete as to labour and overhead) and that the labour and overhead costs incurred in the process totalled Rs. 720, the cost of normal spoilage will be worked out as shown below :

	I Normal spoilage at the end of process (included in equivalent units)			II Normal spoilage at beginning or during process (excluded from equivalent units)	
	Units	Material	Labour & Overhead	Material	Labour & Overhead
Completed and transferred	600	600	600	600	600
Normal spoilage	100	100	100	—	—
Work-in-process (50%)	400	400	200	400	200
Equivalent units	1,100	1,100	900	1,000	800
Cost	Total Rs. 1,820	Rs. 1,100	Rs. 720	Rs. 1,100	Rs. 720
Cost per equivalent unit		Re. 1.00	Re. 0.80	Rs. 1.10	Re. 0.90
Cost of completed units $600 \times 1.80 = \text{Rs. } 1,080$ (before spoilage)		(600×1.00) Rs. 600	(600×0.80) Rs. 480	(600×1.10) Rs. 660	(600×0.90) Rs. 540
Normal spoilage		$= \text{Rs. } 1,080$ (100×1.00) Rs. 100	(100×0.80) Rs. 80	$= \text{Rs. } 1,200$ —	—
		$= \text{Rs. } 180$		—	—
Cost of completed units (a)		Rs. 1,260		Rs. 1,200	

Cost of work-in-process (b)	(400 × 1.00)	(200 × 0.80)	(400 × 1.10)	(200 × 0.90)
	Rs. 400	+ Rs. 160	Rs. 440	+ Rs. 180
		= Rs. 560		Rs. 620
Total cost (a) + (b)		Rs. 1,820		Rs. 1,820

The cost of lost units may be adjusted separately under the foregoing method II. Assuming that the 1,100 units at a cost of Rs. 1,100 were introduced from the previous process, the unit cost of Re. 1.00 is no longer valid because 100 units were lost. The adjusted unit cost to include the spoilage is, therefore, Rs. 1,100 / (1,100 - 100) Rs. 1.10, i.e. an increase of Re. 0.10 per unit. The elementwise unit costs are as follows :—

Transfer from previous process (1,100 units)		Re. 1.00
Labour and overhead		0.90
Adjustment for lost units		0.10
Total		Rs. 2.00
Cost of 600 units completed and transferred (600 × 2.00)		Rs. 1,200
Cost of work-in-process :		
From previous department (400 × Rs. 1.10)	Rs. 440	
Labour and overhead (400 × $\frac{1}{2}$ × Re. 90)	Rs. 180	Rs. 620

If the spoiled units can be sold as scrap, the scrap value is credited to the process account as the cost of the spoilage or loss. Assuming that the spoilage of 100 units in the foregoing illustration can be sold as scrap for Rs. 50, the calculations will be as follows :

Process cost				
Material	Rs. 1,100			
Less Scrap	Rs. 50			
	Rs. 1,050			
Labour and Overhead	Rs. 720			
Total	Rs. 1,770			
Equivalent units :				
	Material	Labour and Overhead		
Completed	600	600		
Work-in-process	400	200		
	1,000	800		
	Rs. 1,050	Rs. 720		Total
Cost per equivalent unit	$\frac{1,050}{1,000} = \text{Rs. } 1.05$	$\frac{720}{800} = \text{Rs. } 0.90$		Rs. 1.95
Cost of completed units 600 × Rs. 1.95			Rs. 1,170	
Cost of normal spoilage			Rs. 50	
Cost of work-in-process 400 × Rs. 1.05 + 200 × Rs. 0.90			Rs. 600	

Process Account			
Material	Rs. 1,100	Normal loss	Rs. 50
Labour and Overhead	720	Finished Production	1,170
		Work-in-process	600
	<hr/> Rs. 1,820		<hr/> Rs. 1,820

Another illustration to show the different treatments of losses occurring at (i) the beginning of a process or during it and (ii) the end of a process is given in Example 7.9.

Abnormal Loss and Abnormal Gain. Abnormal spoilage or defective work may arise in a process due to unforeseen factors. The cost of such abnormal loss is not included in the cost of the process but the average cost of the lost units is charged to an Abnormal Loss Account which is credited with the scrap and closed to the Profit and Loss Account. Thus, in computing the value of abnormal loss, scrap value of the abnormal lost units will be ignored but in working out the loss for charging to Profit and Loss Account, this will be taken into consideration.

Sometimes, when the actual loss in a process is less than the anticipated loss, the difference between the two is considered to be abnormal gain. The value of the abnormal gain is calculated in the same way as described above for abnormal loss and is credited to an Abnormal Gain Account which is ultimately closed to the Profit and Loss Account. The scrap value of the normal anticipated loss in the process where abnormal gain occurs is credited to the process account with the result that the net debit to the process is the cost of abnormal gain less the value of scrap for the normal loss.

Input 1,000 kgs.

Output 950 kgs.

Normal loss (10% of input) = 100 kgs.

Sale value of normal loss as scrap (Re. 1 per kg.) = Rs. 100 (Cr. Process Account)

Cost of Process = Rs. 4,600

Abnormal gain = 950 kgs. - 900 kgs. = 50 kgs.

Cost of normal process = Rs. 4,600 - Rs. 100 = Rs. 4,500

Cost per kg. (normal production) = $\frac{\text{Rs. 4,500}}{900} = \text{Rs. 5}$

Cost of abnormal gain = Rs. 5 \times 50 = Rs. 250 (Dr. Process Account)

Process Account

	Units	Rs.		Units	Rs.
Process cost	1,000	4,600	Normal loss	100	100
Abnormal gain	50	250	Completed production	950	4,750
	<hr/> 1,050	<hr/> 4,850		<hr/> 1,050	<hr/> 4,850

Abnormal Gain Account

Process Account	Rs. 50	Process Account	Rs. 250
Profit and Loss Account	200		
	<hr/> Rs. 250		<hr/> Rs. 250

As the actual loss incurred is only 50 kg. the actual income from sale of scrap is Rs. 50 only as against the anticipated income of Rs. 100. The decrease in income reduces the abnormal gain from Rs. 250 to Rs. 200.

5. *Normal and abnormal losses occurring in a process but there is no closing stock or the closing stock is fully complete.*

EXAMPLE 7.6.

The product of a company passes through three distinct processes to completion. These processes are known as A, B and C. From past experience it is ascertained that wastage is incurred in each process as under :

Process A	2% of input
Process B	3% of input
Process C	10% of input

The normal process loss occurring in the three processes is regularly sold at the rates of 50 paise (Process A), Re. 1 (Process B) and Rs. 2 (Process C) per unit respectively. The output of each process passes immediately to the next process and the finished units are transferred from Process C to finished stock. The following expenses were incurred :

	A	B	C
Material consumed	40,000	20,000	15,000
Director labour	42,000	42,000	35,000
Manufacturing expenses	14,600	8,380	13,920

20,000 units have been issued to Process A at a cost of Rs. 80,000. The output from each process has been as under :

Process A	19,500
Process B	18,800
Process C	16,600

There was no stock of work-in-process in any process.

Prepare the process accounts and abnormal wastage account, assuming that the abnormal wastage collected together for all the three processes was sold in one lump and fetched a price of Rs. 10,000. (C.W.A., Inter)

ANSWER :

For Process A :

- Actual wastage $20,000 - 19,500 = 500$ units
- Normal wastage $- 2\% \text{ of } 20,000 = 400$ units
Scrap sale value $400 \text{ Re } 0.50 \text{ Rs. } 200$
- Abnormal wastage $\text{Actual wastage less normal wastage}$
 100 units

Rs. 1,76,000

Prorata Cost $\frac{(20,000 - 400) \times 19,600}{19,600}$

Rs. 1,76,000

- Cost of abnormal wastage $\frac{100}{19,600} \times 100 = \text{Rs. } 900 \text{ (rounded off)}$

Process A

	Units	Rs.		Units	Rs.
Units introduced	20,000	80,000	Transfer to Process B	19,500	1,75,500
Material		40,000	Normal wastage	400	200
Labour		42,000	Abnormal wastage	100	900
Overhead		14,600			
	<u>20,000</u>	<u>Rs. 1,76,600</u>		<u>20,000</u>	<u>Rs. 1,76,600</u>

Calculations in respect of Processes B and C are made in a similar manner.

Process B

	Units	Rs.		Units	Rs.
Transfer from Process A	19,500	1,75,500	Transfer to Process C	18,800	2,44,400
Material		20,000	Normal wastage	585	585
Labour		42,600	Abnormal wastage	115	1,495
Overhead		8,380			
	<u>19,500</u>	<u>Rs.2,46,480</u>		<u>19,500</u>	<u>Rs.2,46,480</u>

Process C

	Units	Rs.		Units	Rs.
Transfer from Process B	18,800	2,44,400	Transfer to Finished Stock	16,000	2,88,000
Material		15,000	Normal wastage	1,880	3,760
Labour		35,000	Abnormal wastage	920	16,560
Overhead		13,920			
@	<u>18,800</u>	<u>Rs.3,08,320</u>		<u>18,800</u>	<u>Rs.3,08,320</u>

Abnormal Wastage Account

Process A	900	Sale	10,000
Process B	1,495	Loss (Profit and Loss Account)	8,955
Process C	16,560		
	<u>Rs. 18,955</u>		<u>Rs. 18,955</u>

6. *Process consisting of partially completed closing stock* : We had seen earlier that under the job cost system, work-in-progress is determined either by taking physical stock of partly completed production or by a technical estimation of the extent to which a job has been processed, expressed as a percentage of the total or whole job. As the determination of work-in-process is required to be made frequently in process costing—after every accounting period instead of once in a financial year as in the case of jobs—the method of physical stock-taking is expensive and so, not suitable in process costing. Technical estimation is, therefore, more appropriate and is commonly adopted for determining equivalent or effective units. In some industries, it is possible to determine the stage of completion of work-in-process fairly accurately on the basis of estimated machine operation time or man-hours required for completion of a process and the time actually taken for incomplete production. Where such an exact calculation is not possible, an average or estimate may be used. Based on past experience, the work-in-process at the end of a period is, in some concerns, roughly assessed, say, as one-third or one-half complete.

EXAMPLE 7.7.

The following data in respect of a Process II are given below :

Month : January, 19xx

Transferred from Process I : 20,000 units, cost Rs. 80,000

Units completed and transferred to finished stock : 18,000

Work-in-process at the end of the month :

Materials 2,000 units, 50% complete

Labour 2,000 units, 25% complete

Overhead 2,000 units, 25% complete

Cost of input during the month :

Material Rs. 9,500

Labour Rs. 9,500

Overhead Rs. 9,000

Required :

1. The cost of goods transferred to finished stock and the cost of work-in-process at the end of January, 19xx.

2. If the material added during the month has the effect of increasing the final output by 4,000 units, calculate the costs as at 1 above, other conditions remaining the same.

ANSWER :

1. Equivalent units :

Materials $18,000 + 2,000 \times \frac{1}{2} = 19,000$

Unit cost = Rs. 9,500 : 19,000 = Re. 0.50

Labour and Overhead $18,000 + 2,000 \times \frac{1}{2} = 18,500$

Unit cost = (Rs. 9,500 + Rs. 9,000) / 18,500 = Re. 1.00

Cost per unit transferred from Process I = Rs. 80,000 / 20,000 = Rs. 4

Cost of finished goods transferred = $18,000 \times (\text{Rs. } 4 + \text{Re. } 0.5 + \text{Re. } 1) = \text{Rs. } 99,000$

Cost of closing work-in-process :

Materials $2,000 \times \text{Rs. } 4 + 2,000 \times \frac{1}{2} \times \text{Re. } 0.5$ Rs. 8,500

Labour and overhead $2,000 \times \frac{1}{2} \times \text{Re. } 1$ Rs. 500

Rs. 9,000

Units from previous process 20,000

Units added in current process 4,000

24,000

Units transferred to finished stock 22,000

Units in work-in-process 2,000

24,000

2. Equivalent units :

Materials $22,000 + 2,000 \times \frac{1}{2} = 23,000$

Unit cost = Rs. 9,500 / 23,000 = Re. 0.4130

Labour and overhead $22,000 + 2,000 \times \frac{1}{2} = 22,500$

Unit cost = Rs. 18,500 / 22,500 = Re. 0.8222

Adjusted cost of input from the previous process

= Rs. 80,000 / 24,000 = Rs. 3.3333 per unit

Cost of finished goods transferred = $22,000 \times (\text{Rs. } 3.3333 + \text{Re. } 0.4130 + \text{Re. } 0.8222) = \text{Rs. } 4,5685$
= Rs. 1,00,510*

Cost of work-in-process :

Materials $2,000 \times \text{Rs. } 3.333 + 2,000 \times \frac{1}{2} \times \text{Re. } 0.4130$ = Rs. 7,079

Labour and overhead $2,000 \times \frac{1}{2} \times \text{Re. } 0.8222$ Rs. 411

*Rounded off.

Rs. 7,490

7. Normal loss or abnormal loss involved—closing stock partially complete :

EXAMPLE 7.8.

A company operates a department producing a component which passes through two processes. During November, materials for 40,000 components were put into process. There was no opening process stock. 30,000 were finished and passed to the next process. Those not passed forward were calculated to be one-half finished as regards wages and overhead. The costs incurred were as follows :—

	Rs.
Direct material	10,000
Factory overhead	12,000
Direct wages	8,000

Of those passed to the second process, 28,000 were completed and passed to finished stores. 200 were scrapped, which was not abnormal. 1,800 remained unfinished in process, one-quarter finished as regards wages and overhead. No further process materials costs occur after introduction at the first process until the end of the second process, when protective packing is applied to the completed components. The process and packaging costs incurred at the end of the second process were :

Direct material	4,000
Factory overhead	4,500
Direct wages	3,500

Prepare a cost analysis statement for November, accounting for total costs incurred, analysed into elements of cost for process, covering finished and partly finished items.

(I. C. M. A., Part IV—Adapted)

ANSWER :

Process I	Material	Labour	Overhead	Total
Units completed	30,000	30,000	30,000	
Closing inventory	10,000	5,000	5,000	
Effective production	40,000	35,000	35,000	
Current process cost	Rs. 10,000	Rs. 8,000	Rs. 12,000	Rs. 30,000
Process cost per unit	Re. 0.25	Re. 0.2286	Re. 0.3429	
Closing inventory cost	Rs. 2,500*	Rs. 1,143*	Rs. 1,714*	Rs. 5,357
Material transferred to Process II				Rs. 24,643

$$(*10,000 \times \text{Re. } 0.25 = \text{Rs. } 2,500)$$

$$10,000 \times \text{Re. } 0.2286 \times \frac{1}{2} = \text{Rs. } 1,143$$

$$10,000 \times \text{Re. } 0.3429 \times \frac{1}{2} = \text{Rs. } 1,714)$$

Process II				
Units completed	28,000	28,000	28,000	
Closing inventory	1,800	450	450	
Effective production	29,800	28,450	28,450	
Process costs	Rs. 24,643	Rs. 3,500	Rs. 4,500	Rs. **36,643
Cost per unit	Re. 0.827	Re. 0.123	Re. 0.158	
Closing inventory cost	Rs. 1,490	Rs. 55	Rs. 70	Rs. 1,615
	(1,800 × 0.827)	(1,800 × 0.123 × $\frac{1}{2}$)	(1,800 × 0.158 × $\frac{1}{2}$)	

Finished stock	Rs. 35,028
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**The direct material cost of Rs. 4,000 for protective packing is added only after the end of the process and is, therefore, charged to finished stock only.

Cost Analysis Sheet

Process I			Nov.....	
	Units	Rs.	Units	Rs.
Direct material	40,000	10,000	Transfer to Process II	30,000 24,643
Direct wages		8,000		
Fy. overhead		12,000	Work-in-process	10,000 5,357
	40,000	30,000	40,000	30,000

Process II				
	Units	Rs.	Units	Rs.
Process I material	30,000	24,643	Finished stock	28,000 35,028
Direct material		4,000	Normal loss	200 —
Direct wages		3,500	Work-in-process	1,800 1,615
Fy overhead		4,500		
	30,000	36,643	30,000	36,643

Another illustration to show the computations when wastage occurs (a) at the beginning of a process or during it, and (b) at the end of a process, is given below :

EXAMPLE 7.9.

The finished products of a factory pass through two processes, the entire material being placed in process at the beginning of the first process. From the following production and cost data relating to the first process, work out the value of the closing inventory and of the value of the materials transferred to the second process if spoilage of 1,000 kgs. occurs (a) during the first process and (b) at the end of the first process.

<i>Process I</i>	Rs.	Kgs.
Opening inventory	10,000	
Material	27,500	
Labour	50,000	
Manufacturing overhead	40,000	
Opening inventory (25 % complete)		4,000
Put into process		12,000
Transferred to Process II		10,000
Closing inventory (20 % complete)		5,000

(I. C. W. A., Final—Adapted)

ANSWER :

(a) As spoilage occurs during the process, its cost will be charged both to the complete production and the closing inventory :

<i>Effective units</i>	<i>Material</i>	<i>Labour</i>	<i>Overhead</i>
From :	Kgs.	Kgs.	Kgs.
Opening inventory	*0	3,000	3,000
Current input	6,000	6,000	6,000
Total complete units	6,000	9,000	9,000
Closing inventory	5,000	1,000	1,000
Effective units	11,000	10,000	10,000

*As entire material is placed in the process at the beginning of the first process, inventory (both opening and closing) is taken as 100% complete in regard to material.

	<i>Material</i>	<i>Labour</i>	<i>Overhead</i>
Current process cost	Rs. 27,500	Rs. 50,000	Rs. 40,000
Process cost per unit	Rs. 2.5	Rs. 5	Rs. 4
Closing inventory*	Rs. 12,500	Rs. 5,000	Rs. 4,000
			Rs. 21,500

Cost of material transferred to the second process :

Opening inventory + Process cost — Closing inventory = Rs. 10,000 + Rs. 1,17,500 — Rs. 21,500 = Rs. 1,06,000

[*Material : $5,000 \times \text{Rs. } 2.5 = 12,500$

Labour : $5,000 \times \text{Rs. } 5 \times 20\% = 5,000$

Overhead : $5,000 \times \text{Rs. } 4 \times 20\% = 4,000$

Rs. 21,500]

(b) If spoilage occurs at the end of the process, its cost will be charged only to the finished production and not to the closing inventory. The calculations will be as follows :—

<i>Effective units</i>	<i>Material</i>	<i>Labour</i>	<i>Overhead</i>
From :			
Opening inventory	0	3,000	3,000
Current input	7,000	7,000	7,000
Total complete units	7,000	10,000	10,000
Closing inventory	5,000	1,000	1,000
Effective units	12,000	11,000	11,000
Process cost	Rs. 27,500	Rs. 50,000	Rs. 40,000
Process cost per unit	Rs. 2.29	Rs. 4.55	Rs. 3.63

Closing inventory

		Rs.
Material	$5,000 \times \text{Rs. } 2.29$	= 11,450
Labour	$5,000 \times \text{Rs. } 4.55 \times 20\%$	= 4,550
Overhead	$5,000 \times \text{Rs. } 3.63 \times 20\%$	= 3,630
		Rs. 19,630

Cost of material transferred to second process = Rs. 10,000 + Rs. 1,17,500 — Rs. 19,630
= Rs. 1,07,870

8. Process consisting of partially completed opening stock :

When there is opening stock of work-in-process, the production completed during the period comes out in two batches. One batch consists of the production from the opening stock which was only partly processed during the previous period and the second batch consists of production completed out of the fresh units started in the process in the current period. As costs during the two periods vary, each will have different costs and the cost of the first batch will consist partly of the cost carried over from the previous period.

Depending upon the particular assumption made regarding the flow of cost in the process, the calculation of the costs of the finished goods transferred to the next process and the closing work-in-process may be made under either of the two methods, viz. the *weighted average cost* method or the *first-in, first-out (FIFO)* method. The accounting procedures and computation of equivalent units under these methods are discussed below :

(1) *Weighted Average method* : According to this method, the opening work-in-process is treated as a part of current production although this was partly processed in the earlier period and its percentage of completion is not taken into account for the calculations. The cost of the opening work-in-process is added to the cost incurred in the current period and average unit cost is worked out by dividing it by the equivalent units, as illustrated in the following example :

Process A

Period : September, 19xx

Opening Stock (work-in-process)—10,000 units, 40% complete, Rs. 10,000

Units brought into process—50,000

Cost incurred

Material Rs. 60,000

Labour Rs. 25,000

Overhead Rs. 15,000

Transfer to Process B : 40,000 Completed units (entirely complete production)

Closing Stock (work-in-process)—20,000 units, 75% complete

(i) The input and output are reconciled as follows :

	Units		Units
Opening work-in-process (40%)	10,000	Units Completed	40,000
Units started	50,000	Closing work-in-process (75%)	20,000
	<hr/> 60,000 <hr/>		<hr/> 60,000 <hr/>

(ii) Computation of equivalent units :

Units completed 40,000

Closing work-in-process (75%) 15,000

Equivalent units 55,000

It should be noted that in calculating the equivalent units under the weighted average method, the work done in the past is taken to have been done in the current period and, therefore, the stage of completion of the opening work-in-process is immaterial.

(iii) Total Cost = Rs. 10,000 + Rs. 60,000 + Rs. 25,000 + Rs. 15,000 = Rs. 1,10,000

(iv) Cost per equivalent unit = Rs. 1,10,000/55,000 = Rs. 2

(v) Cost of completed units transferred to Process B = 40,000 × Rs. 2 = Rs. 80,000

Cost of closing work-in-process (75%) = 20,000 × 75% × Rs. 2 = Rs. 30,000

Rs. 1,10,000

The Process Account will be shown as follows :

Process A

Period : September, 19..

	Units	Completion	Rs.		Units	Completion	Rs.
Work-in-process (b/f)	10,000	40%	10,000	Transferred to Process B	40,000	100%	80,000
Material	50,000		60,000	Work-in-process (c/f)	20,000	75%	30,000
Labour			25,000				
Overhead			15,000				
	60,000		Rs. 1,10,000		60,000		Rs. 1,10,000

(2) *First-in, First-out method* : This method is based on the assumption that the material in process moves on a first-in, first-out basis, so that the work on the opening stock is completed first, before the materials put into the process during the current period are taken up. The units completed during the process being usually more than the opening stock, it is assumed that no units from the opening work-in-process will be left incomplete and so none of them will find place in the closing work-in-process. Under the FIFO method, the costs for work completed in a period are worked out in two parts, i.e. separately for (a) opening work-in-process completed, and (b) units started and completed in the period.

In the FIFO method, the method of calculation of equivalent units is different as the units completed from opening work-in-process and from current production have to be accounted for separately. Taking the earlier data, the equivalent units will be computed as follows :—

	<i>Equivalent units</i>
Opening stock, work completed in the current period ($10,000 \times 60\%$)	6,000
Units completed during the period :	
Units started less closing stock ($50,000 - 20,000$)	30,000
Closing stock, work done in the current period ($20,000 \times 75\%$)	15,000
Completed equivalent production	<u>51,000</u>
Or simply :	
Units completed	
From opening work-in-process	6,000
From current production	30,000
Closing work-in-process	15,000
Completed equivalent production	<u>51,000</u>
Alternatively, the equivalent units may be calculated as follows :	
Units completed during the period	40,000
Closing stock : work done ($20,000 \times 75\%$)	15,000
	<u>55,000</u>
Less opening stock ; work already completed in previous period ($10,000 \times 40\%$)	4,000
Completed equivalent production	<u>51,000</u>
or	
Opening stock ; work incomplete ($10,000 \times 60\%$)	6,000
Input : incomplete	50,000
	<u>56,000</u>
Less closing stock : work not completed ($20,000 \times 25\%$)	5,000
Completed equivalent production	<u>51,000</u>

The current units cost will be :

$$\frac{\text{Total current costs}}{\text{Effective units production}} = \frac{\text{Rs. } 60,000 + \text{Rs. } 25,000 + \text{Rs. } 15,000}{51,000} = \text{Rs. } 1.9608$$

Cost of finished production transferred to Process B will be arrived at in two parts, as follows :

	Cost per unit	
(a) From opening stock	Rs.	
Opening stock (cost from preceding period)	10,000	
Cost added (cost incurred to complete, this period)		
$10,000 \times 60\% \times \text{Rs. } 1.9608$	11,764	
	Rs. 21,764	Rs. 2.1764
(b) From current production		
$(30,000 \times 100\% \times \text{Rs. } 1.9608)$	58,824	
	Rs. 80,588	Rs. 5.8824
Cost of closing work-in-process (none from opening stock but all from units started)		
$20,000 \times 75\% \times \text{Rs. } 1.9608$	Rs. 29,412	

(The cost of finished production may also be worked out by deducting the cost of closing work-in-process, which is calculated first, from the total debits in the process account.)

A few illustrations of the above two methods are given in Examples 7.10 to 7.13.

EXAMPLE 7.10 (Weighted average method)

The following figures related to a single industrial process .

Quantity of work-in-process at commencement—80,000 units

Cost of work-in-process at commencement,

	Rs
Material	29,600
Wages	6,600
Overhead	5,800

During the period under review, a further 32,000 units were introduced and the additional costs were :

Material : Rs. 1,12,400 ; Wages : Rs. 33,400 ; Overhead : Rs. 30,200. At the end of the period, 28,000 units were fully processed, and 12,000 units remained in process. This closing stock was complete as regards material cost and one-third complete as regards wages and overhead.

Using the average method of valuation, tabulate these production and cost figures to give quantities, unit values, and total values for completed ou. it and for each of the three elements comprising the closing work-in-process. (I. C. M. A., Part IV—Adapted)

ANSWER :

Statement of production :

Input	Units	Output	Units
Opening work-in-process	8,000	Finished goods	28,000
Introduced in process	32,000	Closing work-in-process	12,000
	40,000		40,000

Calculation of equivalent units :

	Material	Labour	Overhead
Units completed	28,000	28,000	28,000
Closing work-in-process	12,000	4,000	4,000
Effective units	40,000	32,000	32,000

Cost of equivalent units under the average cost method is worked out as follows :

	Rs. 29,600 + Rs. 1,12,400	
Material	<u>40,000</u>	= Rs. 3.55 per unit
	Rs. 6,600 + Rs. 33,400	
Labour	<u>32,000</u>	= Rs. 1.25 per unit
	Rs. 5,800 + Rs. 30,200	
Overhead	<u>32,000</u>	= Rs. 1.125 per unit

Valuation of work-in-process :

Material, 100% complete	= 12,000 × Rs. 3.55	= Rs. 42,600
Labour, 1/3rd complete	= 12,000 × 1/3 × Rs. 1.25	= Rs. 5,000
Overhead, 1/3rd complete	= 12,000 × 1/3 × Rs. 1.125	= Rs. 4,500

Total Cost = Rs. 52,100

Cost of finished goods :

Material, 100% complete	= 28,000 × Rs. 3.55	= Rs. 99,400
Labour, 100% complete	= 28,000 × Rs. 1.25	= Rs. 35,000
Overhead, 100% complete	= 28,000 × Rs. 1.125	= Rs. 31,500

Total Cost = Rs. 1,65,900

The Process Account is shown below :

Process Account

	Units	Rs.	Rs.		Units	Rs.	Rs.
Opening stock :	8,000			Finished goods :	28,000		
Material		29,600		Material		99,400	
Labour		6,600		Labour		35,000	
Overhead		5,800		Overhead		31,500	
			42,000				1,65,900
Introduced :	32,000	1,12,400		Work-in-process:	12,000		
Material		33,400		Material (100% complete)		42,600	
Labour		30,200		Labour (1/3rd complete)		5,000	
Overhead			1,76,000	Overhead (1/3rd complete)		4,500	
							52,100
			2,18,000				2,18,000

EXAMPLE 7.11. (FIFO method)

G.H. and Co. manufacture a product in one process. Process costing is followed and work-in-process stocks at the end of each month are valued on FIFO basis.

At the beginning of a month the inventory of work-in-process showed 400 units, 40 per cent complete, valued as follows :—

Materials	Rs. 3,600
Labour	Rs. 3,400
Overhead	Rs. 1,000
Total	Rs. 8,000

During the month, actual issue of materials to production was Rs. 68,500. Wages and overheads in the month amounted to Rs. 79,800 and Rs. 21,280 respectively. Finished production taken into stock in the month was 2,500 units. There was no loss in process.

At the end of the month, the work-in-process inventory was 500 units, 60 per cent complete as to labour and overhead and 80 per cent complete as to materials.

Prepare a process cost sheet showing total and units costs. (*I. C. W. A., Final—Adapted*)

ANSWER :

Statement of Production

	Units		Units
Opening work-in-process	400	Finished production	2,500
New units added	2,600	Closing work-in-process	500
	<u>3,000</u>		<u>3,000</u>

Calculation of effective production

	Units	Completion	Material	Labour	Overhead	Total
Units completed :						
From opening inventory	400	60%	240	240	240	
From current input	2,100	100%	2,100	2,100	2,100	
Closing inventory	500	80%	400			
		60%		300		
		60%			300	
			<u>2,740</u>	<u>2,640</u>	<u>2,640</u>	
Current cost			Rs. 68,500	Rs. 79,800	Rs. 21,280	
Current cost per unit			Rs. 25,000	Rs. 30,227	Rs. 8,061	Rs. 63,288

	Units	Completion	Material	Labour	Overhead	Total
Cost of finished production :						
From opening inventory	400	60%	Rs. 3,600	Rs. 3,400	Rs. 1,000	Rs. 8,000
						+ Rs. 15,189*
						Rs. 23,189
From current production	2,100	100%				Rs. 1,32,905**
Cost of closing inventory	500	80%	Rs. 10,000			Rs. 1,56,094
		60%		Rs. 9,068		
		60%			Rs. 2,418	
						<u>Rs. 21,486</u>

[*(400 × 60% × Rs. 63,288)]

** (2,100 × 100% × Rs. 63,288)]

Process Cost Statement

	Units	Completion		Cost	Cost per unit
			Rs.	Rs.	Rs.
Opening work-in-process					
Material	400	40%	3,600		
Labour			3,400		
Overhead			1,000		
				8,000	
Input added	2,600	0%			
Material			68,500		
Labour			79,800		
Overhead			21,280		
				1,69,580	
Less Closing work-in-process	500			Rs. 1,77,580	
Material		80%	10,000		
Labour		60%	9,068		
Overhead		60%	2,418		
				Rs. 21,486	43.00
Cost of production (Finished stock)	2,500	100%		Rs. 1,56,094	62.44

EXAMPLE 7.12. (Applying average cost method) •

Product A passes through three processes. In January 19.., the following information is obtained in respect of Process 2 :—

Opening stock : 2,800 units valued at Rs. 1,200 made up of

Rs. 700 for material

Rs. 150 for labour

Rs. 350 for overheads

Transfer from process 1 : 14,000 units at Re. 0.20 each

Transfer to process 3 : 12,000 units

	Rs.
Direct material added in Process 2	1,560
Direct labour amounted to	2,000
Production overhead incurred	4,400

Units scrapped : 2,000 on completion of process 2

Closing stock : 2,800 units

Degree of completion :	Material	80%
	Labour	60%
	Overheads	60%

Note : 10% loss during production considered normal loss. Units scrapped realised Re. 0.40 each.

Prepare a statement of the cost of Process 2 and show the unit cost of units transferred to Process 3.
(I. C. W. A., Inter)

ANSWER :

Physical Flow

Input units

Opening stock	2,800
Transfer from Process 1	14,000

Output units

Normal loss	1,400
Abnormal loss	600
Transfer to Process 3	12,000
Closing stock	2,800

16,800

16,800

(Units processed = 14,000 + 2,800 (opening stock) - 2,800 (closing stock) = 14,000 Equivalent units. Normal loss = 10% of 14,000 = 1,400)

	<i>Material</i>		<i>Overhead</i>	
	%	Units	%	Units
Normal loss	—	—	—	—
Abnormal loss	100	600	100	600
Transfer to process 3	100	12,000	100	12,000
Closing stock	80	2,240	60	1,680
		14,840		14,280

Cost evaluation statement

	<i>Materials</i>	<i>Labour</i>	<i>Overhead</i>	<i>Total</i>
Opening stock	700	150	350	1,200
From Process 1	2,800	—	—	2,800
Added in the process	1,560	2,000	4,400	7,960
	5,060	2,150	4,750	11,960
Less Scrap value of normal loss @ Re. 0.40	560	—	—	560
Total	Rs. 4,500	Rs. 2,150	Rs. 4,750	Rs. 11,400
Cost per equivalent unit	Re. 0.303	Re. 0.150	Re. 0.333	Re. 0.786

EXAMPLE 7.13. (Applying FIFO method)

In a process unit the undernoted data were collected from the Grinding department for the month of June 19xx.

Physical data :

Work-in-process as on 1.6 (50% completed)	20,000 units
Receipt during the period	1,80,000 units
Issues to the next process	1,70,000 units
Work-in-process as on 30.6 (50% completed)	26,000 units

Financial data :

Work-in-process as on 1.6	Rs. 20,000
Cost from previous process	6,000
Cost incurred in this process	—
Total	26,000
Cost transferred from previous department during the month	1,81,800
Cost incurred in the process during the month	96,480

Calculate the cost of units in process on 30th June, 19xx, and the cost of units transferred to the next process using FIFO method of inventory valuation. (Ignore lost units as normal.)

(J. C. W. A., Inter)

ANSWER :
Physical flow

		Equivalent units	
Input (units)	Output (units)	Previous process	This process
Opening work-in-process 20,000	Completed from : Opening work-in-process processed 20,000	—	10,000
Receipt during the period 1,80,000	Current input processed during the period (1,70,000—20,000) 1,50,000	1,50,000	1,50,000
	Normal Loss 4,000	—	—
	Closing work-in-process 26,000	13,000	13,000
	<u>2,00,000</u>	<u>1,63,000</u>	<u>1,73,000</u>

Cost :		Total Rs.	Rs.	Rs.
Opening work-in-process	26,000			
Current cost				
From previous department	1,81,800	1,81,800		
Incurred in this process	96,480			96,480
	<u>Rs. 3,04,280</u>			
Current cost per equivalent unit		Rs. 1.1153	Rs. 0.5577	
		(Total Rs. 1.6730)		

Evaluation statement :

1,70,000 units transferred	Rs.
From opening work-in-process	26,000
Add current cost to complete opening work-in-process (10,000 × Rs. 0.5577)	5,577
Add units completed from current production (1,50,000 × Rs. 1.6730)	2,50,954
	<u>Rs. 2,82,531</u>
Closing work-in-process (13,000 × Rs. 1.6730)	Rs. 21,749
	<u>Rs. 3,04,280</u>

It will be noted that the cost from previous process forms the "raw material" of the current process and it has not the effect of adding any units to the latter. The cost transferred from previous department during the month (Rs. 1,81,00) is, therefore, apportioned to the equivalent units completed during the month and the units carried over as work-in-process.

The weighted average and the FIFO methods have their merits and limitations. The weighted average method is simpler of the two and is widely used in practice but it levels out the costs in different periods and does not, therefore, correctly reflect the extent of change of costs from period to period. In the latter respect, the FIFO method is more suitable from the point of view of control as the past and current costs are segregated. The FIFO method is, however, complicated and tracing out the costs in two parts from process to process becomes tedious, particularly when a large number of processes is involved. As we will see later, the FIFO system is neither suitable nor rational when spoiled units are involved because apportionment of such units between the opening

inventory and current production is not possible. The FIFO method is, therefore, not much used in practice. Whenever used, it is applied to the last process from where the finished product emerges.

The difference in the results obtained by the two methods would not be significant or would disappear altogether if :

- (i) There is no opening inventory, in which case the question of first-in, first-out does not arise at all.
- (ii) Opening inventory is very small compared to the fresh units introduced in the process.
- (iii) The stage of completion of opening inventory is not sufficiently advanced so that the previous costs have practically no effect on current costs.
- (iv) There is not much difference in costs from period to period.

(3) *Last-in, first-out (LIFO) method* : Calculation of the values of closing work-in-process and finished stock is made under yet another method, viz. the LIFO method. In this method, the cost of the opening work-in-process is charged to the closing work-in-process rather than to the finished product units so that the latter bear the current costs. This is illustrated below :

Opening work-in-process : 10,000 units, 50% complete with regard to labour and overhead

Material	Rs. 3,000
Labour	Rs. 4,000
Overhead	Rs. 4,000
	<u>Rs. 11,000</u>

Units brought into process : 20,000

Cost incurred :

Material	Rs. 15,000	
Labour	Rs. 26,250	
Overhead	Rs. 35,000	
	<u>Rs. 76,250</u>	Rs. 87,250

Transfer to next process : 15,000 completed units

Closing work-in-process : 15,000 units, 50% complete as to labour and overhead

The equivalent units and the costs will be computed as follows :—

	Material	Labour	Overhead
From Current input			
Units completed	15,000	15,000	15,000
Closing work-in-process	100% 5,000	50% 2,500	50% 2,500
	<u>20,000</u>	<u>17,500</u>	<u>17,500</u>
Equivalent units			
Current cost	Rs. 15,000	Rs. 26,250	Rs. 35,000
Cost per equivalent unit	Re. 0.75	Rs. 1.50	Rs. 2.00
Cost of closing work-in-process, arrived at in two parts :			
From opening stock			
10,000 units	Rs. 3,000	Rs. 4,000	Rs. 4,000
From current input			
5,000 Re. 0.75	Rs. 3,750		
2,500 Rs. 1.50		Rs. 3,750	
2,500 Rs. 2.00			Rs. 5,000
	<u>Rs. 6,750</u>	<u>Rs. 7,750</u>	<u>Rs. 9,000</u>
Completed stock, 15,000 units at current cost	Rs. 11,250	Rs. 22,500	Rs. 30,000
Total cost	<u>Rs. 18,000</u>	<u>Rs. 30,250</u>	<u>Rs. 39,000</u>
			Rs. 87,250

Accounting of Inter-Process Profits

Inclusion of inter-process profit creates complications in the accounts. As the internal profits remain merged in process stock, work-in-process, and finished stock, suitable adjustment is required to be made in the Balance Sheet in order to exclude such unrealised profit. No adjustment is, however, necessary for the finished goods sold as the internal profits are already realised on the sales. In order to avoid these complications, many accountants prefer not to include inter-process profits in the accounts. The line of argument is that the main purpose of showing inter-process profits, viz. comparison of costs with the market price, may be served equally well by keeping suitable records, making separate cost analysis and reports outside the accounts, or by introducing a system of standard costing wherein the standard costs of each process may be known.

When inter-process profit is included in the accounts, it is advisable to have three columns in the ledger to indicate the cost, profit, and the total. This facilitates the calculation of the profit to be provided for inclusion in closing stock in each process and in the final finished stock. The method is illustrated below :

EXAMPLE 7.14.

A product passes through three processes before it is completed and transferred to finished stock. The following data are available for a month :

	Process No. 1 Rs.	Process No. 2 Rs.	Process No. 3 Rs.
Opening stock (at prime cost)	2,000	12,000	10,000
Direct material	13,000	20,000	40,000
Direct labour	10,000	10,500	50,000
Factory Overhead	10,000	25,000	25,000
Closing stock (at prime cost)	5,000	6,000	32,000

Inter-process transfers of output included profits at the following rates :—

Process 1 to Process 2	—20% on transfer price
Process 2 to Process 3	—25% on transfer price
Process 3 to Finished Stock	—10% on transfer price

Inter-process profits included in the opening stock were :—

In Process 2	—Rs. 2,000
In Process 3	—Rs. 2,800
In Finished Stock	—Rs. 10,000

Finished stock :

Opening balance	—Rs. 25,000
Closing balance	—Rs. 33,000
Sales during the month	—Rs. 3,00,000

Complete the process accounts, determine the gross profit for the month and indicate the values at which the closing stock will appear in the Balance Sheet on the last day of the month.

ANSWER :

Process No 1 Account

	Total Rs.	Cost Rs.	Profit Rs.		Total Rs.	Cost Rs.	Profit Rs.
Stock (b/f)	2,000	2,000	—	Transfer to Process No. 2	37,500	30,000	7,500
Direct material	13,000	13,000	—				
Direct labour	10,000	10,000	—				
Less Stock (c/f)	5,000	5,000	—				
Prime cost	20,000	20,000	—				
Fy. overhead	10,000	10,000	—				
Process cost	30,000	30,000	—				
Profit at 20% on transfer price (25% on cost)	7,500		7,500				
	37,500	30,000	7,500		37,500	30,000	7,500
Stock (c/f)	5,000	5,000	—				

Process No 2 Account

	Total Rs.	Cost Rs.	Profit Rs.		Total Rs.	Cost Rs.	Profit Rs.
Stock (b/f)	12,000	10,000	2,000	Transfer to Process No. 3	1,32,000	90,212	41,788
Transfer from process No. 1	37,500	30,000	7,500				
Direct material	20,000	20,000	—				
Direct labour	10,500	10,500	—				
Less Stock (c/f)	80,000	70,500	9,500				
	6,000	5,288	712*				
Prime cost	74,000	65,212	8,788				
Fy. overhead	25,000	25,000	—				
Process cost	99,000	90,212	8,788				
Profit at 25% on transfer price (1/3rd of cost)	33,000		33,000				
	1,32,000	90,212	41,788		1,32,000	90,212	41,788
Stock (c/f)	6,000	5,288	712				

*The proportionate profits on closing stock in this and other processes are worked out in the following manner :

$$\text{Profit} = \text{Rs. } 6,000 - \frac{\text{Rs. } 70,500}{\text{Rs. } 80,000} \times \text{Rs. } 6,000 = \text{Rs. } 6,000 - \text{Rs. } 5,288 = \text{Rs. } 712$$

Process No 3 Account

	Total Rs.	Cost Rs.	Profit Rs.		Total Rs.	Cost Rs.	Profit Rs.
Stock (b/f)	10,000	7,200	2,800	Transfer to Finished Stock			
Transfer from Process No. 2	1,32,000	90,212	41,788		2,50,000	1,86,562	63,438
Direct material	40,000	40,000	—				
Direct labour	50,000	50,000	—				
	2,32,000	1,87,412	44,588				
Less Stock (c/f)	32,000	25,850	6,150				
Prime cost	2,00,000	1,61,562	38,438				
Fy. overhead	25,000	25,000	—				
Process cost	2,25,000	1,86,562	38,438				
P ofit at 10% on transfer price (th of cost)	25,000		25,000				
	2,50,000	1,86,562	63,438		2,50,000	1,86,562	63,438
Stock (c/f)	32,000	25,850	6,150				

Finished Stock Account

	Total Rs.	Cost Rs.	Profit Rs.		Total Rs.	Cost Rs.	Profit Rs.
Stock (b/f)	25,000	15,000	10,000	Sales	3,00,000	1,77,374	1,22,626
Transfer from Process No. 2	2,50,000	1,86,562	63,438				
	2,75,000	2,01,562	73,438				
Less Stock (c/f)	33,000	24,188	8,812				
	2,42,000	1,77,374	64,626				
Gross Profit	58,000		58,000				
	3,00,000	1,77,374	1,22,626		3,00,000	1,77,374	1,22,626
Stock (c/f)	33,000	24,188	8,812				

Provision for Profit Account

	Rs.	Rs.		Rs.	Rs.
Profit and Loss Account			Balance (b/f)		
Proportion of provision not required for Process 2		1,288	Process 2	2,000	
Finished stock		1,188	Process 3	2,800	
Balance (c/f)			Finished stock	10,000	14,800
Process 2	712		Profit and Loss A/c		
Process 3	6,150		Additional provision required for Process 3		3,350
Finished stock	8,812	15,674			18,150
		18,150	Balance (b/f)		
			Process 2	712	
			Process 3	6,150	
			Finished stock	8,812	15,674

Analysis of gross profit for the month :

	Rs.	Rs.	
Process 1		7,500	
Process 2	33,000		
Plus Provision not made	1,288	34,288	
Process 3	25,000		
Less Provision	3,350	21,650	
Finished Stock	58,000		
Plus Provision	1,188	59,188	Rs. 1,22,626*

*This agrees with the profit in the Finished Stock Account.

Balance Sheet

Process Stock—Process 1		Rs. 5,000
Process 2	Rs. 6,000	
Less Profit	712	Rs. 5,288
Process 3	Rs. 32,000	
Less Profit	6,150	Rs. 25,850
Finished Stock	Rs. 33,000	
Less Profit	8,812	Rs. 24,188

Operation Costs. A manufacturing process may sometimes be subdivided into a number of parts, each of which is known as an operation. Thus, a process is a large sphere of activity which may consist of several operations. *Operation costing* refers to the determination of cost of operations rather than the processes. It is a special type of process costing in which the cost centre is taken to be an operation instead of a process. With operation costing, cost control may be exercised more effectively because the individual area of activity and responsibility is considerably reduced.

The procedure for costing of operations is broadly the same as for process costing. Material, labour, and expenses are recorded against each operation and transfer of costs is made from one operation to another as in the case of process costing. Sometimes, the operation cost may comprise only the conversion cost, and so, in order to find out the product cost, the cost of material is added to the conversion costs of each of the operation centres through which the product passes.

A general ledger is maintained for each operation but if the operations are too many, keeping accounts for such a large number of operations increases clerical costs. Furthermore, split up of the main process centre into smaller operation cost centres makes the distribution of manufacturing overhead difficult. Accounts are, therefore, maintained for the large process only and an analysis sheet is maintained for the various operations as a subsidiary document.

The main problem to be faced in determining operation costs arises when the manufacture of a product involves a number of operations and the output of one operation passes on to the next. As waste, rejection and scrap may also be involved at the various stages, the output of an operation is less than its input. The problem is further complicated when all the operations are carried out simultaneously on mass production lines and the quantities dealt with in each operation bear no direct relationship with one another.

The method of calculating unit operation cost is illustrated below. For the sake of simplicity, only labour costs have been shown but overhead and material costs may be worked out in a similar manner.

Unit Operation Costs

Operation No.	Input units	Output units	Rejected units	% of rejection to output	Ratio per 100 of output	Amount	Labour Costs (Rs.)		
							Per 100 units of input	Per 100 units of output	Per 100 units of final output
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	1,00,000	84,000	16,000	19.50	250	100	.10	.119	.250
2	1,20,000	80,000	40,000	50	210	120	.10	.150	.210
3	1,40,000	1,26,000	14,000	11.11	140	140	.10	.111	.140
4	96,000	80,000	16,000	20	126	96	.10	.120	.126
5	84,000	80,000	4,000	5	105	84	.10	.105	.105
100 Rs. 540							Re. 0.50	Re. 0.605	Rs. 0.831

The calculations are explained below :

Ratio per 100 units of output : The purpose of calculating this ratio is to determine the number of units to be put in hand in each operation so that at the end of the final operation 100 good units are obtained. In the foregoing example, 250 units of input yield 100 units of the final product. Starting backwards, in the 5th operation, 84,000 units of input yield 80,000 units of output. To get 100 final units, 105 units have, therefore, to be put in the beginning of operation 5. Similarly, 126 units should be put in operation 4 to get 105 units, 140 in operation 3 to get 126 units, and so on. The ratio for an operation is obtained by increasing the ratio for the next operation (in Col. 6) by the percentage of rejection as per Col. 5 for the operation under consideration. Thus for operation 4, the ratio will be,

$$105 \div 20\% \text{ of } 105 = 126$$

Computation of cost : The labour costs per 100 units of input and output (Cols. 8 and 9) are obtained by dividing the total cost of labour (Col. 7) by the input and output (Cols. 2 and 3) respectively and multiplying by 100. The labour cost per 100 units on the number finally passed as good (Col. 10) is obtained by multiplying the cost per 100 units of input in Col. 8 by the ratio in Col. 6.

The calculations show that in order to produce 100 units, 250 units should be initially put in the process. The labour cost per 100 units of final output is Re 0.831 and the labour costs of waste per 100 units is Re 0.331 (Re 0.831 - Re 0.500). The labour cost of work-in-progress at the end of each operation may be determined in the following manner

		Units in progress	
At the end of operation No. 1	$\frac{\text{---}}{100}$	Re 0.119	
		Units in progress	
At the end of operation No. 2	$\frac{\text{---}}{100}$	[Re (0.119 + 0.150 + 50% of Re 0.119) = Re 0.329]	
		Units in progress	
At the end of operation No. 3	$\frac{\text{---}}{100}$	[Re (0.329 + 0.111 + 11.11% of Re 0.329) = Re 0.476]	
		Units in progress	
At the end of operation No. 4	$\frac{\text{---}}{100}$	[Re (0.476 + 0.120 + 20% of Re 0.476) = Re 0.691]	
		Units in progress	
At the end of operation No. 5	$\frac{\text{---}}{100}$	[Re (0.691 + 0.105 + 5% of Re 0.691) = Re 0.831*]	

* This agrees with the total in Col. 10

Operating Costs. Operating costs refer to the costs of undertakings which do not manufacture any product but which provide services. Such undertakings are : transport concerns (shipping, air, railways, and motor transport), catering establishments (hotels, hostels, canteens, and cafeteria), and public utility undertakings like gas, electricity, and steam generating, hospitals, theatres, schools, laundries, etc. In many factories, utility services like motor transport, power house, hospital, and canteen are departmentally run divisions which provide services to the producing departments of the factory. Because of the diverse nature of activities carried out in service undertakings, the cost system used is obviously different from that for manufacturing concerns. The main differences arise in :

- (i) the adoption of a suitable cost unit which is not a job or process but is related to the service rendered, e.g. unit of electricity, cubic metre of gas, tonne-kilometre or passenger-kilometre of transport services, and
- (ii) the manner of collection and allocation of the costs to the cost unit.

For the purpose of illustration, the costing system applied in motor transport concerns will be considered.

Motor Transport Costing

Costing in a motor transport undertaking consists of determining the operating cost of each vehicle and applying this cost to find out the cost per unit of service rendered by a vehicle. The cost unit is selected with proper care keeping in view the needs of each concern, the weight, bulk, and types of good carried, and the distance covered in each trip. The units commonly in use are an hour of work, a tonne, a kilometre, tonne or quintal-kilometre, and passenger-kilometre ; the last one is used in undertakings that provide service for carrying passengers. The tonne-kilometre or the passenger-kilometre is actually two units combined in one and is based on the contention that in the operation of a transport, both the weight of the load (or the number of passengers) and the distance should be taken into account. A load of 2 tonnes carried for 10 kilometres would be equivalent to $2 \times 10 = 20$ tonne-kilometres. Similarly, a load of 10 tonnes carried for 2 kilometres would also be equivalent to 20 tonne-kilometres. It may be seen that although the tonne-kilometre in both the cases is the same, factors like loading and unloading time, return distance, and running costs may be different in each case. The tonne-kilometre does not, therefore, provide a perfect unit for cost apportionment. When, however, the loads carried on each trip do not vary widely and the distances covered are also appreciable, the tonne-kilometre provides a very useful unit for the calculation of average transport costs. The weighted average tonne-kilometre should be adopted for the purpose of cost computation as shown below :

1st trip	: 10 tonnes \times 52 kilometres	= 520 tonne-kilometres
2nd trip	: 8 tonnes \times 100 kilometres	= 800 tonne-kilometres
3rd trip	: 5 tonnes \times 10 kilometres	= 50 tonne-kilometres

23 tonnes 162 kilometres 1,370 tonne-kilometres

(The correct tonne-kilometres are 1,370 and not 23 \times 162 = 3,726)

Log Book : A Log Book is maintained for each vehicle to record details of trips made by the vehicle during a specified period of time ; usually on a daily basis. A specimen of a log book is given in Fig. 7.14. The details shown in the log book enable the management to make suitable allocation of vehicles, to avoid unnecessary or duplicate trips, and to avoid waste or idle running capacity. The records also provide data for the proper allocation of costs and in this respect these may be compared with the production details available in a manufacturing concern.

Compilation of costs : Costs are classified and accumulated under the following three heads :

1. **Fixed or stand-by costs :** These costs which include garage charges, insurance, taxes, licence, depreciation, wages of drivers and cleaners, establishment costs of workshop and Head Office, and general service, are constant and are incurred irrespective of the extent of the run of a vehicle. While some of these costs such as wages of drivers, cleaners etc. are in the nature of direct or traceable fixed costs and can be allocated to specified vehicles, the rest are suitably apportioned to each vehicle.
2. **Maintenance costs :** These are costs of a semi-variable nature and include expenditure on repairs, maintenance, tyres, tubes, accessories, and spares.

VEHICLE LOG BOOK											
Vehicle No. : Make and specification : Registration/Licence No. : Date of purchase :					Date : Driver : Route on which plying (Route No.) :						
PARTICULARS OF TRIPS											
Trip No.	From	To	Distance (Kilometres)	Weight carried (Quintals)		Quintal Kilometres	Time				
				Out	En-route		Out	In	Actual	Standard	Variation from standard
Total											
Supplies : Petrol/Diesel Lubricating Oil						Time : Driver Cleaner Mechanic				Details of delays :	
Notes : (i) The reverse page of the log book contains entries of all repairs and maintenance carried out on the vehicle. All maintenance stores and spares drawn and the labour time utilised for repairs and maintenance are recorded. (ii) For passenger-carriers, the form of the log book is suitably modified to record the number of passengers carried in each trip.											

Fig. 7.14. Vehicle Log Book

3. **Operating and Running costs :** These are variable costs, the extent of which depends upon the trips made and distance run by a vehicle. Such costs include cost of fuel (petrol or diesel oil), lubricating oil etc. and wages of driver and cleaner (if payment is related to distance run or trips made, or when drivers and cleaners are specially detailed to man specific vehicles). Operating and running costs may be easily allocated to each vehicle.

The costs for each vehicle, suitably analysed under the above mentioned heads, are compiled periodically in a Cost Sheet or Cost Summary (see Fig. 7.15).

VEHICLE COST SHEET							
Vehicle No. :	Period :		Total no. of trips :		Budgeted	Actual	
Route No. :			Total distance run :				
			Total weight carried :				
			Total units :				
			Total hours operated :				
Nature of expenditure	Current		Last month		Budgeted		Variance
	Amount Rs.	Per unit Rs.	Amount Rs.	Per unit Rs.	Amount Rs.	Per unit Rs.	
<i>Operating & Running Costs</i>							
Fuel							
Lubricating oil							
Drivers' wages							
Cleaners' wages							
Mechanics' wages							
Sub-Total							
<i>Maintenance Costs</i>							
Tyres & tubes							
Spares							
Repairs							
Overheads							
Sub-Total							
<i>Fixed Costs</i>							
Insurance							
Licence & taxes							
Depreciation							
Establishment and general charges							
Sub-Total							
Total							

(i) Total cost per day, per hour or per kilo-metre may be shown.
(ii) Performance averages like average weight per day or per trip and average distance per day or per trip may be shown on the reverse side of the form.

Fig. 7.15. Vehicle Cost Sheet

Determination of operating costs for each vehicle serves the following purposes :

- (a) Control of operating and running costs and avoidance of waste of fuel and other consumable material.

- (b) Cost of running own vehicles may be compared with hired or other forms of transport.
- (c) Facilitates quotation of hiring rates to outside parties who ask for the transport service.
- (d) Cost of running a vehicle may be compared with that of another similar vehicle.
- (e) If transport service is treated as a separate department or service cost centre, the costs to be charged to departments which requisition the services of the Transport Department may be easily determined.
- (f) Suitable information is obtained for efficient routing of vehicles.
- (g) Costs of idle vehicles and lost running time are easily obtained.

Two practical examples illustrating the determination of transport cost are given below :

EXAMPLE 7.15.

Iron ore is transported from two mines 'A' and 'B' and unloaded at plots in a railway station. A is at a distance of 10 kms. and B is at a distance of 15 kms. from the railhead plots. A fleet of lorries of 5 tonne carrying capacity is used for the transport of ore from the mines. Records reveal that the lorries average a speed of 30 kms. per hour when running and regularly take 10 minutes to unload at the railhead. At mine 'A', loading time average 30 minutes per load while at mine 'B' loading time average 20 minutes per load.

Drivers' wages, depreciation, insurance, and taxes are found to cost Rs. 9 per hour operated. Fuel, oil, tyres, repairs and maintenance cost Rs. 1.20 per km. Draw up a statement showing the cost per tonne-kilometre of carrying iron ore from each mine. (I. C. W. A., Inter)

ANSWER :

Mine	A	B
Distance (kms.)	10	15
Tonne-kilometres	50	75
	(5 × 10)	(5 × 15)
Time involved per trip (mts.) :		
Loading	30	20
Unloading	10	10
Running (including empty return)	40	60
	(20 × 2)	(30 × 2)
	80	90
Costs :		
Drivers' wages, Depreciation, Insurance & tax	12	13.5
	80	90
	(— × Rs. 9)	(— × Rs. 9)
	60	60
Fuel, Oil, Tyres, Repairs and maintenance	24	36
	Rs. 36	Rs. 49.5
	Re. 0.72	Re. 0.66
Cost per Tonne-kilometre		

EXAMPLE 7.16.

A cement company employs 12 trucks of 5 tonnes capacity each for transport of limestone from the nearby quarry which is situated at a distance of 5 kilometres from the factory. The vehicles run empty on the outward journey and return with limestone. Each truck makes five trips to the quarry and back in a day. In an average month of 25 working days during a year,

one day is lost by each truck on an average for repairs and maintenance. The other particulars are as under :—

Fuel : 2.50 kilometres per litre of diesel at Rs. 2 per litre

Purchase price of each truck : Rs. 72,000

Life of each of the trucks : 12 years but all the trucks have completed 5 years of service

Driver's salary : Rs. 800 per month each.

One cleaner is employed for all the trucks at a salary of Rs. 500 per month

Repairs and maintenance : Rs. 2,400 per annum per truck

Fixed expenses like taxes, tyres, batteries etc. : Rs. 6,000 per annum per truck.

The company proposes to replace these 12 trucks by 6 new trucks of 10 tonnes capacity each. The new trucks will also remain idle for one day a month for repair and maintenance. The other particulars relating to the new trucks are :—

Fuel : 2 kilometres per litre of diesel

Repairs and maintenance : Rs. 2,400 per annum per truck

Fixed expenses like taxes, tyres, batteries etc. : Rs. 7,200 per annum per truck

Purchase price : Rs. 1,40,000 each

Life : 7 years.

The old trucks can be sold at 10% of the book value calculated on straight line method of depreciation. The drivers rendered surplus in the changover are proposed to be retrenched on payment of a compensation of Rs. 15,000 each immediately after the replacement proposal is put through. Interest is ignored.

Required :

Prepare a comparative cost statement showing the operating cost per tonne of limestone in the existing situation and under the replacement proposed using straight line method of depreciation. (I.C.W.A., Final)

ANSWER :

	Physical data	
	Present	Proposed
No. of Trucks	12	6
Capacity of each Truck	5 Tonnes	10 Tonnes
No. of days per annum	288	288
No. of Trips per day	5	5
Total Tonnage of limestone carried per annum	86,400 (12 × 5 × 288 × 5)	86,400 (6 × 10 × 288 × 5)
Total distance per annum	1,72,800 kms.	86,400 kms.
Mileage per litre of diesel	2.5 km.	2 km.
Diesel required at Rs. 2 per litre	69,120 litres	43,200 litres
<i>Comparative Cost Sheet for the year</i>		
	Rs.	Rs.
Fuel cost	1,38,240	86,400
Drivers' salary	1,15,200	57,600
Cleaner's salary	6,000	6,000
Repairs & Maintenance	28,800	14,400
Fixed expenses	72,000	43,200
Depreciation	72,000	1,20,000
Unabsorbed depreciation of trucks replaced*		64,800
Compensation of retrenched drivers spread over life of new trucks (6 × Rs. 15,000)/7		12,857
Total Cost	Rs. 4,32,240	Rs. 4,05,257
Cost per tonne	Rs. 5.00	Rs. 4.69

*Unabsorbed depreciation per year is worked out as follows :—

Cost of old Trucks 12 × Rs. 72,000	Rs. 8,64,000
Less depreciation for five years	3,60,000
	<hr/>
Present book value	Rs. 5,04,000
Less amount realised (10%)	50,400
	<hr/>
Unabsorbed depreciation	Rs. 4,53,600
Unabsorbed depreciation per annum (Rs. 4,53,600/7)	Rs. 64,800

As it is not possible to have within the scope of this book, a detailed discussion of the systems of operating costs suitable for numerous types of service undertakings, the broad heads under which costs may be analysed and suitable costs units for which costs may be determined in electricity supply undertakings, hospitals, and canteens are tabulated below.

<i>Undertaking</i>	<i>Cost unit</i>	<i>Heads for analysis of cost</i>
Electricity supply	Kilo-Watt Hour (Unit of electricity)	Fuel Coal, coke, gas, etc. less sale proceeds of cinders and ash Steam Lubricating oil and stores Repairs and maintenance Wages and salaries Sundry stores Depreciation Supervision General
(A cost sheet for electric supply undertaking may be seen in Fig. 4.8)		
Hospital	Per bed occupied or per patient	Salaries Machines & appliances Provisions Lighting, heating, air-conditioning General charges
Canteen	Per meal	Provisions Salaries and wages Cooks Canteen boys Supervisors Fuel Crockery & utensils Consumable stores Fixed charges Depreciation Insurance, Rent, taxes, etc.

Single or Output Costing : This is another variant of process costing employed when production is uniform and consists of only a single product or two or three types of similar products or different grades of the same product, e.g. in mining, quarries, steel production etc. The basic principles are the same as those for the process costing system.

EXAMINATION QUESTIONS

1. Describe the methods used for treatment in contract account of plant used on contract jobs, explaining the particular circumstances in which they can be applied.
(I. C. W. A., Inter)
2. There are two methods of charging a contract cost account for use of Plant. Describe these two methods and state which method is preferable and why.
(I. C. W. A., Inter)
3. A public works contractor secured a contract at a price of £5000,000. Works began on July 1, 19...., and the contract ledger account showed the following items debited up to March 31 in the following year :

		£
Materials		90,000
Wages		105,000
Direct charges		5,000
Plant		16,000
The measurement at March 31st read as follows :		
		£
Total work done certified to date		240,000
Total work done per last measurement		210,000
		<hr/>
Total work done for month		30,000
Less retention money 10%		3,000
		<hr/>
		£27,000
Material on site	5,000	
Less 20%	1,000	4,000
	<hr/>	<hr/>
Amount payable		£31,000

Prepare a proforma account for the contract showing the profit earned to date, and indicate by means of a note, the basis on which you arrive at the amount which might be carried to Profit and Loss Account. Allow for depreciation on the plant at 10% per annum.
(I. C. W. A., Final)

4. The following expenses have been incurred on experimental work which is to benefit three work orders respectively numbered 23, 39 and 58 ;

Salaries and wages	Rs. 4,000
Materials	Rs. 2,000
Hire of special plant	Rs. 800
Factory overhead	Rs. 1,200

It is decided that 10 per cent of the above expenses should first be allocated to work order No. 39 and then the balance would be borne by the three work orders in the proportion of 5 : 3 : 2.

If the prime costs of the work orders be respectively Rs. 25,000, Rs. 30,000 and Rs. 24,000, draw up the Production Cost Accounts of the work orders.

(M. Com., C. U.)

5. Lal & Co. obtained a contract for building a factory for Rs. 10,00,000. Building operation started on 1st April 1963 and at the end of March 1964, they received from the party, a sum of Rs. 3.9 Lakhs being 75 per cent of the amount due on the surveyor's certificate.

The following additional information is given from the books of Lal & Co.

	Rs.
Stores issued to Contract	2,00,000
Stores on hand, 31.3.64	10,000
Wages paid	1,50,000
Plant purchased for Contract	2,00,000
Direct expenses	25,000
Overheads allocated to the Contract	12,000
Work finished but not yet certified, cost	12,000
Plant to be depreciated at 10%	

You are required to prepare an account showing profit and loss on contract as on 31.3.64. Discuss whether Lal & Co. would be justified in taking full amount of this profit to their Profit and Loss Account. (I. C. W. A., Inter)

6. A factory has undertaken a contract for the manufacture of 4,000 articles. The following information has been obtained :

For each article :	Rs.
Material cost	12
Direct wages	10
Selling price	35

The overhead charges consist of (a) fixed Rs. 6,000, (b) variable Rs. 3,600, and (c) semivariable (of which 60% is fixed) Rs. 2,400.

Calculate the profit per article.

What would be the profit per article if the number of articles manufactured were 5,000 and total fixed overhead charges remained unchanged ? (M. Com., C.U.)

7. From the following data, ascertain prime costs (per unit) of two products X and Y. Assume that there is no regular cost accounting system in this small factory.

(a) Extract from the financial accounts for the year 1976 are—

	Rs.
Material	
Balance as on 1.1.67	15,000
Purchase during the year	2,10,000
Total	2,25,000
Balance as on 31.12.67	7,500
Consumption during the year	2,17,500
Wages incurred	67,000
Sale proceeds of chippings	720 (income)

- (b) As per production records, total quantities of X and Y, produced during the year were 5,000 and 500 units, respectively. The opening and the closing balances of the work-in-progress were almost the same and, therefore, ignored.
- (c) All materials purchased and the balances in stock were direct materials, meant only for the product X. The raw material for the product Y was from borings recovered from the product. Total quantity of borings recovered during the year was 20 tonnes and the entire quantity was consumed in the product Y. The rate may be estimated, Rs. 100 per tonne.
- (d) 75 tonnes of chippings were recovered from production, i.e. 70 tonnes from the product X and 5 tonnes from the product Y ; out of which, 72 tonnes were sold at the rate of Rs. 10 per tonne and the balance of 3 tonnes should be treated as wastages.
- (e) The total wages of Rs. 67,000 should be analysed as under :—

	Percentage
Product X	60
Product Y	5
Overheads	35
	100

(I. C. W. A., Final)

8. A manufacturing shop can use either machine A or machine B for producing a certain component. The set-up time for A is three hours whereas for B it is only one hour. Explain whether set-up labour should be treated as direct or indirect labour giving reasons. Given that machine A can after setting up turn out 50 components per hour while B can provide only 30, and the cost of operating and setting up labour is the same, determine how big the size of a production run should be to justify the use of machine A in preference to B. *(I. C. W. A., Inter)*

9. (a) What are the features of cost plus contracts ?
 (b) Kapur Engineering Company undertakes long-term contract which involves the fabrication of pre-stressed concrete blocks and the erection of the same on consumer's site. The following information is supplied regarding the contract which is incomplete on 31st March, 1978—

Cost incurred—	Rs.
Direct Materials	2,80,000
Direct Labour	90,000
Overheads	75,000
	<hr/>
	4,45,000
Erection costs to date	15,000
	<hr/>
da	4,60,000
	<hr/>
Contract price	8,19,000
Cash received on account	6,00,000

Technical estimate of work completed to date—

Fabrication—	
Direct Materials	80%
Direct Labour & Overhead	75%
Erection	25%

What profit should be taken into credit for the period up to 31st March, 1978 ?

(I. C. W. A., Inter)

10. (a) Define 'normal and abnormal process losses' explaining the possible causes.
 (b) Eighty units are introduced into a process at a cost of Rs. 1,200. The total additional expenditure incurred by the process is Rs. 720. Of the units introduced, 10% are normally wasted in the course of manufacture. The wasted units possess a value as scrap of Rs. 15 each. Due to abnormal causes only 64 units are produced.

How would you write the process account showing the abnormal wastage ?

(I. C. W. A., Inter)

11. An engineering industry has its own "Chromium Plating" section in which piston rods, approximately equal in size, are electroplated. Chemicals required for cleaning, plating etc. are drawn in bulk. Draw up a procedure for arriving at the unit cost of plating and for charging the cost to individual job-batch orders. Suggest suitable forms for use. *(I. C. W. A., Final)*

12. Micco Ltd., a process company, produces a single end product passing through two processes X and Y. The following figures pertain to the first month's working :

	Rs.
Opening stock	Nil
Direct material purchased	1,00,000
Direct wages paid	70,000
Factory overheads incurred	55,200
Costs : Process X	
Direct materials	64,000
Direct labour	37,000
Overheads	44,400

Process Y	
Direct materials	16,000
Direct labour	33,600
Overheads	10,800

Output : Process X	Units
Completed and passed to process Y	32,000
Passed to abeyance stores	4,000
In process : complete as to direct materials, 25 per cent complete as to labour and overhead	4,000
Process Y : completed and passed to finished stock	22,000
In process, 50 per cent complete as to direct materials, labour and overhead	4,000

Arrive at the cost per unit for each process, the unit and total costs for the processes jointly and the value of the closing stock. (I C W A Final)

13. (a) In what type of industries is process costing generally adopted ?
(b) Discuss with figures the method of treatment of process loss and wastage under a process costing method. (I C W A., Inter)
14. A foundry produces brass castings consisting of 70% copper, costing £450 per ton, and 30% zinc, costing £120 per ton. 10% of the metal charged is lost in melting, i.e. before pouring. Melting costs, other than materials, amount to £50 per ton of metal poured. Good castings produced vary, according to product type, from 50% to 70% of metal poured. The balance, consisting of runners, heads and scrap is returned to store for subsequent use, being valued at cost of metal content only
Prepare costs of metal and melting for products with (a) 50%, (b) 60% and (c) 70% yields. What difference (if any) is made to these figures when the charge of metals in the ratio 70 : 30 is supplemented by 40% addition of scrap metal of this mixture ? (I C M A., Pr Iv)
15. A single product is produced by putting material M through two processes, A and B. The quantity of M in each process varies considerably from time to time. For the month under review the following details are applied

Process A

Opening stock of M	Nil
Introduced during the month	1,200 units of M at £8 per unit
Process costs incurred	£4,200
Output : finished and passed to B	800 units
Closing stock	400 units at 50% completion

Process B

Opening stock	Nil
Process cost incurred by work received	£4,000
Output	340 units
Closing stock	300 units, three-quarters finished
(Assume that no further losses will occur on the closing stock)	
Loss in process : Normal	100 units
Abnormal	50 units (scrapped when two-thirds finished)

- (a) Tabulate figures from the above data to show detailed cost per run for each process : cumulative costs, unit and total, of finished units for each process ; and stock values.
- (b) Prepare cost journal entries for the month. (I C M A., Final)

16. (a) What is the difference between normal spoilage and abnormal spoilage ? How are these treated in the process accounts ?
 (b) Calculate the cost of (i) completed goods, (ii) spoilage and (iii) closing inventory, indicating in each case the number of units from the following data of a single process for the month of January, 1966. Complete materials at Rs. 2 per unit are added at the start. The rate of labour is Rs. 3 per unit and that of overhead is 100 per cent of labour.

	No. of units	State of completion as to labour and overhead
Beginning inventory on 1.1.66	600	1/3 completed
Addition	6,000	
Spoiled from normal course at the end of Process	400	1/2 completed
Lost from abnormal accident at the end of Process	800	3/4 completed
Closing inventory on 31.1.66	1,000	3/5 completed

(I.C.W.A., Final)

17. 1,200 Kgs. of a material were charged to Process 1 at the rate of Rs. 2 per Kg. The direct labour accounted for Rs. 200 and other departmental expenses amounted to Rs. 760. The normal loss is 10 per cent of the input whereas the net production was 1,000 Kgs. If the process scrap is saleable at Re. 1 Per Kg., calculate the value of normal loss and abnormal loss and show the ledger account of Process 1.

(I. C. W. A., Inter)

18. The National Cement Co. produces cement. The summary statement for the month of March is given below :—

Opening inventory—

Material	Tonnes	Rate Rs.	Amount Rs.
Clay	2,000	20	40,000
Lime	1,000	15	15,000
Gypsum	500	25	12,500
Finished cement	2,000	24	48,000

Receipts in the month—

Material	Tonnes	Rate Rs.	Invoice Rs.	Freight Rs.
Clay	8,000	22.50	1,80,000	5,000
Lime	4,000	17.50	70,000	2,500
Gypsum	600	24.00	14,400	710
		Total	2,64,400	Rs. 8,210

Transactions for the month—

- (a) Wages accrued 40,000
 (b) Factory Expenses—
 Depreciation 7,500
 Insurance 2,500 (prepaid)
 Taxes 4,000 (prepaid)
 Gas bill received 10,000
 (c) Production for the month was 10,800 tonnes of which 9,000 tonnes were sold at Rs. 50 per tonne.

Closing inventory—

Clay	3,000 tonnes
Lime	2,000 tonnes
Gypsum	300 tonnes

Materials are priced at the monthly weighted average price.

Prepare a cost sheet, arriving at the cost of production of cement in March.

(I. C. W. A., Final)

19. A company produces three products by processing materials through two distinct processes. Production is continuous, and work-in-process at any time remains unchanged. Accounts for the processes (with work-in-process eliminated) are presented as follows:

Process 1	Tons	£		Tons	£
Materials	150	6,000	Sales A	50	2,000
Labour		2,000	Carried to Process 2	100	10,000
Overhead		4,000			
		<u>12,000</u>			<u>12,000</u>
Process 2	Tons	£		Tons	£
From					
Process 1	100	10,000	Sales B	8	12,000
Materials	60	3,000	Sales C	120	12,000
Labour		3,000	Loss in process	32	—
Overhead		4,000			
Profit		4,000			
		<u>24,000</u>			<u>24,000</u>

- Present these figures in the manner which you consider to be most valuable to management, showing unit cost of operating the process (I C M A, Part IV)
20. An automobile repairing unit undertook an order for the overhaul of 300 engines for a transport company based on actual cost of overhaul plus 10 per cent profit. The repairing unit submitted the following claim:

Direct wages	Rs 50,000
Indirect material	Rs 1,000
Works overhead	Rs 1,00,000
Stores overhead	Rs 1,000
Other overheads	Rs 5,000
	<u>Rs 1,57,000</u>
Profit 10 per cent	Rs 15,700
	<u>Rs 1,72,700</u>

As the cost investigator to report upon the accuracy of the claim, you obtained the following information from a detailed examination of the books of the repairing unit:

- (a) The Overhauling process passes through four different cost centres
 - (i) Stripping down into different components
 - (ii) Overhauling various components
 - (iii) Assembly
 - (iv) Testing
- (b) Direct labour hours for each process for each engine were as follows
 - (i) Stripping 20
 - (ii) Overhauling 80
 - (iii) Assembly 50
 - (iv) Testing 16
- (c) The average rates of labour adopted for each of the cost centres based on actual wages paid.
- (d) The overhead rates per labour hour for each of the cost centres had been ascertained separately.
- (e) No direct materials were used in overhaul. Components required for replacement were supplied by the transport company.
- (f) An analysis of other overheads showed that only 50 per cent related to general and administration overheads and the remaining 50 per cent represented selling and distribution overheads of a component manufactured for sale.

Submit your analysis and comments in report form, giving your recommendations on the amount to be paid by the transport company.

21. The products of a company pass through three separate processes for completion namely, A, B, and C processes. From past experience it is ascertained that wastage is incurred in each process, as 2%, 5% and 10% in process A, B, and C respectively. In each case, the percentage of wastage is computed on the number of units entering process concerned.

The scrap value of the process A, B and C are Rs. 5, Rs. 20, and Rs. 10 per 100 units respectively.

The output of each process is transferred immediately to the next process and the finished units are transferred from process C to stock. Other particulars are given below.

	Process		
	A	B	C
	Rs.	Rs.	Rs.
Material consumed	6,000	2,000	2,000
Direct labour	4,000	3,000	3,000
Manufacturing expenses	4,000	2,000	1,000

20,000 units have been put into Process A at a cost of Rs. 8,000. The output of each process is as under :

Process A	19,600 units
Process B	18,400 units
Process C	16,700 units

There is no stock of work-in-process in any process. Show how the Process Accounts will appear in the books. (M. Com., C.U.)

22. From the understated particulars you are required to prepare a monthly cost sheet of Plastic Toy Manufacture Ltd., showing cost and profit per 1,000 toys. Show also in the form of a summary, the Cost of Sales, Net Profit and Sales for the month. The company manufactures only one type of toy. The opening stock was valued at the same price per 1,000 toys as the production for the month concerned.

Materials :

Basic raw materials	Rs. 1,400 tons at Rs. 5 per ton
Stores	Rs. 50,000

Labour :

Direct	Rs. 16,000
Indirect	3,000

On cost :

Works	25% of direct labour
Office	10% of works total cost

Production for the month (June, 1962)

10,00,000 toys

Sales for the month

9,00,000 toys at Rs. 50 per 1,000

Stock 1st June, 1962

2,00,000

Stock 30th June, 1962

3,00,000 (M.Com., C.U.)

23. Find the cost of production and value of transfers, in process stock and abnormal loss with the undermentioned data :—

Receipt from earlier process	40,000 units
Value of receipts	Rs. 1,44,000

Expended in the process :

Material	Rs. 49,500
Labour	Rs. 26,400
Overhead	Rs. 79,200

Rs. 1,55,100

Transferred to next process

30,000 units

Loss in process

6,000 units

Closing balance in process with 50% completion

4,000 units

The normal loss is assessed at only

4,000 units

(J. C. W. A., Final)

CHAPTER 8

WASTE, SCRAP, SPOILAGE, DEFECTIVE WORK, JOINT PRODUCTS, AND BY-PRODUCTS

Waste, Scrap, Spoilage, and Defective Work. Problems involving waste, scrap, spoilage and defective work arise in one form or the other in almost all manufacturing industries, whether of processing or job type. As a large number of situations arise in different businesses, there is no uniformity in practice, and the methods of accounting of scrap, spoilage, etc., and the interpretations given to these terms vary considerably from one undertaking to another. The terms are also often loosely used : for example, waste and scrap may be taken to mean one and the same thing. or spoilage and defective work may be treated as synonymous. Before consideration of the accounting methods is taken up, the distinction between the various terms should, therefore, be clearly recognised.

Waste : This is the residue such as smoke, dust, gases, slag etc., which arises in course of a manufacturing process and has practically no measurable sale or utility value. In certain types of processes and operations, some material physically disappears on account of shrinkage, evaporation, etc. with the result that the quantity of the output is less than the input. Such wastage is termed *invisible waste* to distinguish it from the former type of waste, i.e. *visible waste* where the residual waste is physically present. In some industries, the waste instead of fetching any value, creates a problem for its disposal which entails further costs. Special arrangements have, for instance, to be made for disposal of waste and refuse, effluent, obnoxious gases, etc.

Scrap : This is also in the form of incidental material residue coming out of certain types of manufacturing processes but it is usually in small amounts and has low measurable utility or market value, recoverable without further processing. Numerous examples of scrap may be given ; scrap may arise in the form of turnings, borings, trimmings, filings, shavings, etc., from metals on which machine operations are carried out ; sawdust and trimmings in the timber industry ; dead heads and bottom ends in foundries ; and cuttings, pieces, and splits in leather industries. Scrap should always be physically available unlike waste which may or may not be present in the form of a residue.

Spoilage (or Spoiled work) : When production does not come up to the standard specification or quality, it has to be rejected outright. The components or materials are so damaged in the manufacturing process that they cannot be brought back to the normal specification by repairs or reconditioning. Some spoiled work may be sold as seconds but in most cases, the entire production is sold for small value in the form of scrap or treated as waste if it has no market value. Spoilage involves not only loss of material but also of labour and manufacturing overhead incurred up to the stage when the spoilage was incurred.

Defective Work : This is the production below standard specification or quality but which can be retrieved by bringing it up to the standard by incurring some more expenditure, termed as *Salvage costs, Re-work costs, or Rectification costs*.

The accounting of waste, scrap, spoilage, and defective work involves the following :—

- (i) Costing or valuation of the waste, scrap etc.
- (ii) Accounting in product costs.
- (iii) Control of waste, scrap, etc.

The discussions that follow keep the above three aspects in view.

Accounting and Control of Waste. Since waste has practically no value, its accounting is relatively simple. The effect of the waste is to reduce the quantity of output ; in order to arrive at the unit cost of the process, operation, or job, the total cost of the process etc. is distributed over the reduced output, i.e. the units of good production only. The cost of *abnormal waste* should, however, be excluded from the total cost and charged to the Profit and Loss Account (Costing Profit and Loss Account where no integral system of accounting is maintained).

REPORT ON WASTE						
Department :				Period		
Production Order No. or Process or Job No.	Units of product	Actual Waste (Quantity)	Percentage of actual waste to production	Normal waste percentage	Variance percentage	Remarks (Remedial measures)
Total						
Average						

Fig. 8.1. Report on Waste

Control is exercised over the quantum of waste arising in a process or operation usually through standards set for the normal percentages of visible and invisible wastes that may be anticipated to arise in various manufacturing processes or operations. The actual waste is watched against these standards and periodically reported to the management. A suitable form for such a report is shown in Fig. 8.1. Where standard costing is in use, waste in excess of normal is reflected as material usage variance.

Sometimes a demand may develop for the waste, e.g. where a factory situated nearby wants to utilise the waste for further processing or as a substitute raw material for its existing process. In such a situation, it is necessary to assign a value to the waste for the purpose of accounting and for the fixation of suitable price to be obtained from the purchaser. If no market price is available, a convenient method is to evaluate on the basis of market price of the original material substituted by the waste.

Accounting and Control of Scrap. Scrap, like waste, is an unavoidable residue material arising in the process of manufacture but the basic difference between scrap and waste is that while waste may not have any value, scrap must necessarily have a value, though a comparatively small one. Scrap may be sold or re-used in some process. In some industries, arising of scraps of various types in significant quantities is a regular feature and in such cases, it would be worthwhile having a proper administrative set-up for control of scrap. A Scrap Survey Committee may be constituted which would be responsible for such matters, as (i) classifying the various types of scrap, (ii) assessing the quantum of each and (iii) deciding upon the manner of their use or disposal.

There are several methods of accounting for scrap, as discussed below :

(a) *Sales credited to revenue* : In this method, the scrap is not costed and its value does not, therefore, appear separately in the cost accounts. Only a quantitative record of the scrap returned from the shops to storeroom is maintained and the sale value realised from time to time is credited to the Profit and Loss Account as miscellaneous revenue. The unit cost of production is, therefore, inclusive of the cost of scrap. The method is simple and is found suitable, (i) when the scrap has a relatively small realisable value after taking into account the cost of its disposal and marketing, (ii) when its market is uncertain, and (iii) when there is a violent fluctuation in the market price. The method, however, does not permit an effective control over the quantity of scrap arising from the various manufacturing processes.

(b) *Credit to overhead* : In this and in the following method, the scrap is assigned a cost. The cost is usually the sale value of the scrap less selling and distribution costs. If the scrap has no ready market but has only utility or re-use value, a standard or estimated valuation should be made. Scrap returned to storeroom is costed at the assigned value and is taken as a credit to manufacturing overhead. The effect of this credit is to reduce the overhead recovery rate. When predetermined overhead rates are in use, it is more convenient to credit an estimated allowance for the scrap instead of the amount of actual scrap. The journal entries for recording the cost of scrap are :

Dr. Scrap Account
 Cr. Factory Overhead Control Account
 (To record the arising of scrap by crediting scrap cost to overhead)

Dr. Cash Account
 Dr. Sundry Debtors Account
 Cr. Scrap Account
 (To record value of cash and credit sales of scrap)

Profit or loss on sale of scrap may be transferred at the year end to the Profit and Loss account. When scrap is sold on a day-to-day basis and no stock is maintained, the journal entry is,

Dr. Cash Account
 Dr. Sundry Debtors Account
 Cr. Factory Overhead Control Account

The method of crediting scrap to overhead is suitable when several production orders are taken in hand at a time, each producing almost identical types of scrap but where it is not possible or practicable from economic point of view to segregate the arisings from each production order. The method is, however, not effective in controlling scrap arising in individual processes or jobs. Another disadvantage is that all products are given credit through the overhead rate for a portion of the scrap, irrespective of the fact that scrap arising in course of manufacture of the various products may not be uniform.

(c) *Credit to jobs* : The scrap is assigned a cost and is traced to the job which yielded the scrap. This affords a reasonable amount of credit to the jobs and the method is particularly suitable when the yields from the various jobs are widely different. The journal entries are :

Dr. Scrap Account
 Cr. Work-in-Progress Account
 (To set up scrap stock by crediting scrap cost to jobs)
 Dr. Cash Account
 Dr. Sundry Debtors Account
 Cr. Scrap Account
 (To record sale of scrap)

When no stock of scrap is maintained, the entries will be made direct to the Work-in-Progress Account without passing through the Scrap Account :

Dr. Cash Account
 Dr. Sundry Debtors Account
 Cr. Work-in-Progress Account

(d) *Transfer to other jobs* : Scrap arising in one job may be issued for utilisation in another job. Such transfers of scrap from one job to another should be effected through material transfer notes. Alternatively, scrap may be returned to storeroom and subsequently issued to another job for utilisation. The latter method is more appropriate when some further processing is required on the scrap before it can be utilised for other jobs.

Control of scrap starts with the designing of the products. At the designing stage, the type, shape, and form of materials which will result in the minimum of waste or the least quantity of scrap in a manufacturing process are decided. The quantity of scrap resulting from a process also depends upon the manufacturing equipment used and the efficiency of the operator who performs the work. In order to minimise scrap, production should be so planned that the best possible equipment is used and properly trained personnel are employed on the jobs. Taking the above factors into consideration, a normal quantity of scrap, anticipated to arise from a process or job is determined. Inventory records are maintained for each type of scrap. The actual quantity of scrap resulting in a process is compared with the normal quantity ; any excess is investigated and corrective action taken. Effective scrap control may be exercised by prompt reporting of these deviations from the norm. A form suitable for reporting on scrap is given in Fig. 8.2.

SCRAP REPORT

Department :		Period :	
Foreman :		Date :	
Type of Scrap	Production Order No	Actual Quantity of output	Allowance normal scrap (Quantity)
		Actual scrap (Quantity)	Normal % of scrap to good production
		Actual % of scrap to good production	Value of scrap
		Allowable (Normal)	Actual
		Difference between normal and actual scrap	
		Quantity	Value
		Reasons for difference and action suggested	

Fig. 8.2. Report on Scrap

Note When scrap cannot be identified with a production order, the second column of the report is left blank.

Accounting and Control of Spoilage. Spoilage arises when the production output is damaged in such a manner and to such an extent that it cannot be used for the original purpose for which it was designed but is to be disposed of in some suitable manner without further processing. The distinction between scrap and spoiled work is that while normal scrap arises mostly as a result of the processing of materials, spoilage occurs due to some defect in operations or materials which may or may not be inherent in the manufacturing process or operation. Further, scrap has always a relatively low but some definite value, but the value of spoilage may range from nought, if it is a waste, to comparatively high values if the spoilage is sold as seconds. Spoilage involves not only the loss of material but also labour and manufacturing overhead.

Spoilage may create two types of situations ; the entire production output in a batch may be rejected as spoiled or only a part may be rejected and the rest passed as good production. The former situation may sometimes arise in certain process types of industries and the latter mainly in job types where one production order or a batch of production may consist of a number of units of a product. The manner of disposal of spoiled production depends upon the nature and extent

of spoilage ; while some of the spoiled work may be sold at a reduced price as *seconds*, the rest may have either a scrap value or may be treated only as waste.

The accounting of spoilage involves three steps :

- (a) ascertainment of the cost of spoilage.
- (b) apportionment of the cost to normal and abnormal spoilage, and
- (c) treatment of the two types of spoilage costs in accounts.

When spoilage is total, i.e. all the units of output are lost, the cost of spoilage is equal to the total cost of material, labour, and overhead incurred up to the spoilage stage less the salvage value. In case of partial spoilage, the total costs should be prorated to good and rejected units of production.

Normal and Abnormal Spoilage. The treatment of normal and abnormal spoilage was discussed in Chapter 1. The method of apportionment of spoilage between normal and abnormal, particularly in the case of job costing, is illustrated below.

Total input	2,000 units
Normal spoilage	5% of input
Spoiled units (included in total output)	240 units (Normal—5% of input, i.e. 100 and the rest, abnormal—140)
Total accumulated cost	Rs. 3,500
Sale value of normal spoilage	Rs. 50 (i.e. Re. 0.50 per unit)
Sale value of abnormal spoilage	Rs. 70
Total input less 5% normal spoilage	1,900 units

$$\text{Cost of abnormal spoilage} = \frac{\text{Rs. 3,500} - \text{Rs. 50}}{1,900} \times 140 = \text{Rs. 254.21}$$

$$\text{Net cost of abnormal spoilage} = \text{Rs. 254.21} - \text{Rs. 70} = \text{Rs. 184.21}$$

The abnormal spoilage of Rs. 254.21 is excluded from costs and charged to Profit and Loss Account. The sale value of abnormal spoilage, i.e. Rs. 70 is credited to the Profit and Loss Account. The cost of normal spoilage remains charged to the production as product cost, i.e. included in the cost of finished output and abnormal spoilage. Therefore,

$$\text{Unit cost of production} = \frac{\text{Rs. 3,450} - \text{Rs. 254.21}}{2,000 - 240} = \text{Rs. 1.8158}$$

An additional production order may be placed for the manufacture of 140 lost abnormal units.

Another practice, usually adopted where products are manufactured on mass production basis, is to charge the cost of normal spoilage to manufacturing overhead and not to the individual production order. When the percentage of scrap arising in certain jobs is comparatively high and it is not possible to identify it by jobs, a suitable method for crediting the value of the scrap is to prorate it on the basis of percentages of scrap anticipated from each job.

Abnormal spoilage and the reasons which give rise to it are prominently brought to the notice of the management through periodical reports. A form of spoilage report may be seen in Fig. 8.3. The spoilage incurred in a department from period to period may also be shown in line or bar charts. (See Fig. 8.6)

Treatment of spoilage is further illustrated in the following example :

EXAMPLE 8.1.

In the month of November, 6,000 tonnes of raw material A costing Rs. 150 per tonne were processed through Unit No. 3 for the manufacture of solvent X.

The total operating cost of this unit No. 3 for the month was Rs. 12,50,000. Of the output, 10% was unusable and disposed of at Rs. 25 per tonne

Prepare a process account for the month's operation of Unit No. 3 assuming that the spoilage was :

- (i) part of the normal production process ;
- (ii) an abnormal loss due to poor quality material. (I. C. M. A., Pt. IV—Adapted)

ANSWER :

Process Account (Unit No. 3)			
		Rs.	Rs.
Raw Material A, 6,000 tonnes @ Rs. 150		9,00,000	
Less disposal value of Scrap, 600 tonnes @ Rs. 25		15,000	
		<hr/>	8,85,000
Operating Cost			12,50,000
			<hr/>
Cost of 5,400 tonnes of solvent X			Rs. 21,35,000
Cost per tonne of solvent X			Rs. 396
Spoilage Account			
Dr.			Cr.
Scrap, 600 tonnes	Rs. 15,000	Sales (cash or credit)	
(ii)			Rs.
Raw Material, 6,000 tonnes @ Rs. 150			9,00,000
Operating Cost			12,50,000
			<hr/>
			21,50,000
Less 10% Abnormal loss			2,15,000
			<hr/>
Cost of 5,400 tonnes of solvent X		Rs.	19,35,000
Cost per tonne of solvent X		Rs.	358
Abnormal Loss Account			
Dr.			Cr.
Scrap, 600 tonnes	Rs. 2,15,000	Sales (cash or credit)	
		Balance (P. & L.)	

Sub-standard Production. When spoiled work has an appreciable market value, it may be sold as a sub-standard product or as *seconds*. Sometimes the spoiled product is sold in different grades such as seconds, thirds, etc. The current market value of the seconds may be taken as the assigned cost of the salvage or scrap material arising out of the spoilage. The total accumulated cost less the assigned cost of the salvage gives the cost of the spoiled work. Apportionment of cost of different grades may be made by any of the following methods (the last two methods follow the principles of joint product costing discussed in another section of this chapter) :

- (a) The total cost is apportioned to all units treating the seconds and thirds at par with the standard of first grade. This may be called 'treatment by neglect' as the cost of spoilage is ignored. This method is not logical as the spoiled production is treated on the same footing as the good

SPOILAGE REPORT								
Department :			Week ending :					
Foreman :								
Production Order No. or Machine No.	Total units produced	Spoiled units	Actual percentage of spoilage to total units produced	Normal percentage of spoilage to total units produced	Cost of spoilage less salvage value	Cost of abnormal spoilage	Reasons for abnormal spoilage	Remedial measures suggested

Fig. 8.3. Spoilage Report

production and while the cost of the seconds or thirds is overcharged, the cost of the first grade is under-assessed. Another disadvantage is that the method is not conducive to effective control over spoilage.

- (b) The cost is assigned to the sub-standard products on the basis of market value less the selling cost of each. A variant of this method is to further deduct an estimated percentage of profit from the sale value. The method is logical and it brings out the effect of spoilage on the cost of first grade production, thus providing adequate basis for control of spoilage.

Having assigned a value to the sub-standard production, its accounting may be done in two ways, as follows :—

Method 1

Production :	Firsts	320	
	Seconds	80	
		—	400 units
Total Cost			Rs. 4,000
Cost per unit			Rs. 10
Assigned value of Seconds			Rs. 7.5 per unit
			Rs.
Dr. Finished Goods			
First at Rs. 10			3,200
Seconds at Rs. 7.5			600
Dr. Rejection Loss (Fy. Overhead)			200
Cr. Work-in-progress			4,000

Method 2

Total Cost	Rs. 4,000
Less: Value of Seconds	Rs. 600
	<hr/>
	Rs. 3,400

Cost per unit (Rs. 3,400 ÷ 320) = Rs. 10.625

The first method is generally applied in the case of job costing. In the second method which is more appropriate in process costing, the loss is reflected in the high cost of the good units. The disadvantage of this method is that past data of losses are not readily available for the purpose of managerial control.

Accounting and Control of Defective Work. Like spoilage, defective work arises when manufacture is not up to the required specification and quality. The main difference between the two is that spoilage cannot be retrieved and is to be sold as it is, but defective work can be reworked and transformed, either back into standard production or as seconds. The problem of accounting of defective work is thus a problem of rework or rectification costs.

Rectification of defective work may be undertaken by the shop in which the work was originally done. In big concerns where the number of such rectifications is large, a separate Salvage Department may be set up for the reworking of all types of defective work. It is assumed that rectification costs would not be heavy and only some minor rectifications should set right the defective work. Before rectification work is taken up, it should be seen whether the estimated cost of rectification would be commensurate with the value obtained and whether the rectification would be more profitable than any other choice available. This may be seen from the example given below :—

EXAMPLE 8.2.

A company draws up the standard cost of a product as follows :

	Rs.	Rs.	Rs.
Direct materials		12	
Direct wages :			
Deptt. A-3 hours	15		
Deptt. B-2 hours	12		
Deptt. C-5 hours	20		
	<hr/>	47	
Factory overhead			
Deptt. A	18		
Deptt. B	18		
Deptt. C	40		
	<hr/>	76	
		<hr/>	
Factory cost			135
Administration cost			12
Selling cost			15
Distribution cost			18
			<hr/>
Total			180
Net profit			20
			<hr/>
Selling price			200

Factory overhead is absorbed by means of departmental hour rates. Analysis of these overheads reveals that in each department a rate of Rs. 2 per hour is required to absorb the variable portion, the balance being of a fixed nature. As a general rule, all production is of first class quality.

After a batch of 1,000 units has been processed through all three departments, inspection reveals that half are faulty. The faulty products can be rectified by completely re-processing through departments B and C. Alternatively, they can be sold for Rs. 120 each.

Present figures which indicate to management the most economic method of dealing with the faulty products. (I.C.M.A., Final—Adapted)

ANSWER :

Time taken (original processing and rectification) :

Deptt. A	$3 \times 1,000 + 0$	= 3,000 hours
B	$2 \times 1,000 + 2 \times 500$	= 3,000 hours
C	$5 \times 1,000 + 5 \times 500$	= 7,500 hours

Fixed cost :

Deptt. A	Rs. 18—(Rs. 2 × 3 hours)	= Rs. 12 per unit
B	Rs. 18—(Rs. 2 × 2 hours)	= Rs. 14 per unit
C	Rs. 40—(Rs. 2 × 5 hours)	= Rs. 30 per unit

Alternative 1. Cost of production including re-processing of 1,000 units :

Direct Material	$1,000 \times \text{Rs. } 12$	Rs. 12,000
Wages and Factory Overhead		
Deptt. A	$3,000 \times \text{Rs. } (5+2) + 1,000 \times \text{Rs. } 12$	= Rs. 33,000
B	$3,000 \times \text{Rs. } (6+2) + 1,500 \times \text{Rs. } 14$	= Rs. 45,000
C	$7,500 \times \text{Rs. } (4+2) + 1,500 \times \text{Rs. } 30$	= Rs. 90,000
		<hr/> Rs. 1,80,000

Administration, Selling and Distribution

Overhead for 1,000 units	Rs. 45,000	
Loss on non-recovery on 500 units re-processed	Rs. 22,500	
	<hr/>	Rs. 67,500
	Total Cost	Rs. 2,47,500
		<hr/> Rs. 2,00,000

Sales : 1,000 units at Rs. 200 each

Loss Rs. 47,500

Alternative 2. Cost of production of 1,000 units, 500 units being scrapped and disposed of :

Sales	$500 \times \text{Rs. } 200 + 500 \times \text{Rs. } 120$	= Rs. 1,60,000
Cost	$1,000 \times \text{Rs. } 180$	= Rs. 1,80,000
	<hr/>	Loss Rs. 20,000

The latter procedure, i.e. (2) is recommended as the loss involved is less.

When it is decided to rectify the defective work, the rectification is undertaken on a *Salvage or Rectification Work Order* and all costs of re-work under material, labour, and overhead are collected against this work order. If the defective production is inherent in the process of manufacture, arising as a normal consequence of productive activity and if it can be identified with specific jobs, the rectification cost is charged to the jobs as cost of manufacturing good units of products. This will have the effect of adding to the cost of the jobs. If the expenditure on rectification is considered abnormal, it is excluded from product costs and charged to the Profit and Loss Account or the Costing Profit and Loss Account, as the case may be.

For the purpose of control of defective work, performance standard is set as in the case of spoilage. The manufacturing operations are examined carefully

REPORT ON DEFECTIVE WORK									
Department : Foreman :		Week ending.....							
Production Order No.	Production quantity (units)	Normal defective work (units)	Actual defective work		Excess defective work		Disposal value of defective work	Cost of rectification	Reasons for excess defective work
			Units	Cost	Units	Percentage of production			

Fig. 8.4. Defective Work Report

consignment, e.g. in a wagon load. In these circumstances, the problem is to apportion the common cost of purchase, transport, and handling to each item of stores. Another example of common cost is in regard to the apportionment of overhead. We had already seen how common costs incurred for the factory as a whole are apportioned to the various service and producing departments and the service department costs are apportioned to producing departments and the producing department costs are apportioned to individual cost units through overhead recovery rates. Selling and distribution overhead is apportioned to sales lines, sales territories, salesmen, etc. on suitable bases.

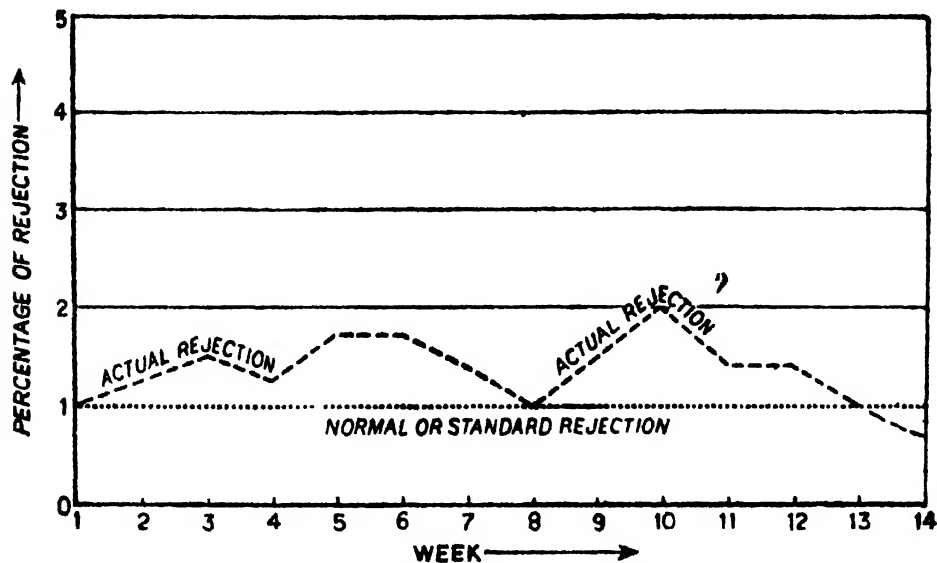


Fig. 8 6 Rejections Control Chart

Another type of common costs, which may more appropriately be termed *joint costs*, arises in analytic type of industries such as petroleum, timber, soapmaking, flour mill, bakery, butchery, cotton ginning, metal extraction etc., where the processing of a batch of materials input results in the joint manufacture of two or more products. For example, in the petroleum refining industry, processing of crude oil results in a variety of finished products like petrol, kerosene oil, diesel oil, paraffin, naphtha, tar etc. In a saw mill, a lot or batch of timber yields several grades of planks, scantlings, saw dust, etc. In such situations, methods have to be devised to apportion the total cost of the manufacturing operations to the several final products.

Common costs and joint costs are interchangeable terms but some accountants consider them to be connoting different concepts. As will be apparent from what has been stated in the previous paragraphs, common costs are those which may be traced to individual products by determining the facilities used by each or on the basis of cause and effect. Joint costs cannot be traced to individual products in this manner. Again, common costs consist of only indirect expenditure whereas joint costs comprise the total costs of manufacture including direct labour and direct material. In an engineering concern, it may be possible to apportion or allocate the common costs like machine time, power, and space costs to each of the various products which are different from one another but in a dairy farm, it

would be difficult to allocate such costs to cream, butter, and skimmed milk produced out of a common process. The latter case is a problem of joint costs.

Joint Products and By-Products. Depending upon the relative importance of the products, the output resulting from a common manufacturing operation or process is referred to as,

- (i) Joint products or Co-products, or
- (ii) Major products and By-products.

Whether a batch of production will be classified under one or the other of these categories, i.e. as joint products or as one or more major products and the rest as by-products is decided with reference to a number of factors like policy of the management, objective of manufacture, profit pattern desired, certainty or uncertainty of market, relative sales of the products, and the revenue derived from them. If the various end-products arising out of a process are equally important in as much as the management has planned to manufacture all of them as major products and/or the sale values realised from each of the products are more or less equal or significant in relation to the total sales, all the products are referred to as joint products. If on the other hand, one of the products yields only an insignificant or low revenue compared to the rest or the market for such a product is not certain, it would be classified as a by-product. Thus, by-products are secondary results of operations and their economic importance is not such as to rank them as joint products or co-products nor is their value so insignificant as to class them as waste or scrap. Hence, by-products may be distinguished from joint products and waste or scrap only in the matter of degree of importance. Scrap arising out of a process has a relatively small value compared to the major product; if it grows in significance and a market is developed for it, the scrap becomes a by-product. Time as well as location may further change the picture; if at any time the by-product attracts a big market, the management may develop its manufacture and it may be produced as a joint product. Again, because of market differences between geographical areas, the same product may be considered to be a by-product by one company and a joint product by another.

The main difference between by-product accounting and joint product accounting is brought out when the sale value method of allocation is used. While the sale value of the by-product is actually entered in the accounts (credit is afforded to the joint costs or the cost of the particular product wherefrom the by-product arises), the relative sale values of joint products are used merely as a basis for apportionment of the joint costs and not entered in the accounts. The objectives of cost apportionment in the two cases are also different. While the costs of joint products are required for pricing and determination of profit of each product, cost apportionment to by-products is mainly for the purpose of giving credit to the process, so that an equitable cost may be determined for the main product or joint products if there be more than one main product.

In several cases, the distinction between joint products and by-products is not sharp enough and no clear cut criteria exist for distinguishing the two. The methods of costing adopted for the two types of products are also different. It is, therefore, essential to decide first, whether a product will be treated as joint product or a by-product before the allocation of the joint costs is proceeded with.

Co-products : A distinction is often made between joint products and co-products. Co-products need not necessarily arise from the same operation or the

same raw materials and the quantity of each co-product is within the control of the manufacturer. For instance, in an automobile manufacturing concern where a number of co-products like cars, jeeps, and trucks of various types are produced, the quantity of production of each product may be changed according to the firm's liking, but in the chemical processing industries, the various joint products come out of the same processes and the quantity of any one of the products cannot ordinarily be altered without changing the quantity of the rest. The line of distinction is, however, thin and it may sometimes be possible to increase the quantity of particular products by controlling wastage or by improved technology.

Accounting of Joint Products. The proportion of each of the joint products derived from a process may either be fixed or variable. The former situation arises mainly in chemical processes where the yield is bound by a chemical reaction formula. In other cases, the varying yield may be due to change in the quality or composition of the raw material inputs or due to variations in the method of processing itself.

The cost accounting of joint products involves the assignment of a portion of the total joint costs to each of the joint products. This is essential, (a) in order to determine the unit cost of the products, (b) for the valuation of inventory, and (c) for the preparation of Profit and Loss Account and Balance Sheet. The joint costs up to the split off point only are taken into consideration as thereafter, the joint products are only individual products and further processing costs can be allocated direct to each product. It may be noted that allocation of costs to joint products (or by-products) does not affect the total profit or loss because all these allocated costs are again totalled up for the purpose of arriving at the final profit or loss.

It is difficult to determine the cost of joint products accurately as no perfectly logical basis exists for the apportionment of such costs to products and most of the methods in use are arbitrary. These methods tend to be only approximate as they are based mainly upon individual opinion. The main principle to be kept in view is that the method of apportionment should be reasonable, logical and reliable. Of the several methods described below, a particular method may be most suitable or appropriate for a particular situation and in such circumstances, the method adopted may be taken to be fairly accurate. No 'true costs' can be determined for joint products but as the individual product costs have a bearing on the profit or loss position and on inventory valuation, whichever be the method adopted for apportionment of the joint costs, it should be logical and should be used consistently.

The various methods of apportioning joint costs are discussed below. The joint costs referred to in the methods may be the historical costs or the standard costs where standard costing system is in use. The use of standard costing in the accounting of joint products is not only possible but also desirable.

1. *Apportionment on the basis of relative sales values* : This method is based on the concept that the apportionment of joint costs to individual products should be made on the basis of their respective capacities to bear joint costs, i.e. on the basis of what the traffic will bear. The costs up to the point of separation or split off are apportioned to the joint products prorata to their sales values. The method has several variants which are illustrated on the next page.

(a) *On the basis of selling price.* In this method which is suitable when the units of production of all the joint products are equal, apportionment of joint costs is made on the basis of the relative selling prices (rates per unit) of the various joint products. Joint costs amounting to Rs. 2 lakhs may, for example, be apportioned to three joint products as follows :—

	Sale price per unit Rs.	Cost apportionment ratio	Apportioned cost
Product 1	2	2/10	Rs. 40,000
„ 2	3	3/10	Rs. 60,000
„ 3	5	5/10	Rs. 1,00,000
Joint cost			Rs. 2,00,000

(b) *On the basis of sales value.* This is a weighted method which takes into account both the selling price and the units sold, as shown below :

Product	Units produced and sold	Sales price per unit (Rs.)	Sale value (Rs.)	Percentage of total sale value	Apportioned cost (Rs.)	Cost per unit (Rs.)
1	45,000	2	90,000	30	60,000	1.33
2	50,000	3	1,50,000	50	1,00,000	2.00
3	12,000	5	60,000	20	40,000	3.33
			Rs. 3,00,000		Rs. 2,00,000	

(c) *On the basis of sales less cost of completion of individual products.* This method is applicable in those cases where after split-off point, further operations are carried out to make the individual products saleable. As the products are sold after completion only, no selling prices are available for prorating at the split-off point. The method consists in deducting the cost of completion of the individual products beyond split-off from the sale price so as to arrive at the value (assumed sales) before completion. This value forms the basis for apportionment. This is illustrated below :

Production	Units produced	Sale price per unit	Processing cost, i.e. cost of completion after split off	Value per unit up to split-off (3) - (4)	Value of total production (assumed sale) up to split-off (2) × (5)	Percentage	Apportioned cost up to split-off	Cost per unit up to split-off
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		Rs.	Rs.	Rs.	Rs.		Rs.	Rs.
1	45,000	2.00	.40	1.60	72,000	28.8	57,600	1.280
2	50,000	3.00	.58	2.42	1,21,000	48.4	96,800	1.936
3	12,000	5.00	.25	4.75	57,000	22.8	45,600	3.800
					Rs. 2,50,000	100	Rs. 2,00,000	

EXAMPLE 8.3.

You are the Management Accountant of a company operating a single chemical process producing from a single raw material four different products A, B, C and D. Your Production Director is considering proposals to discontinue certain work at present done on these products and has, therefore, asked you to prepare a report, giving :

- a statement of the profit made or loss incurred on each of the four products A, B, C and D, under present conditions ;
- an assessment of the change in the profit or loss, given in answer to (a) above, if the proposals being considered were adopted ;
- any recommendations you consider, you should put forward arising out of the assessment.

Your report should be based on the information given below :

The cost of the raw material for the year just ended was Rs. 33,500 and the initial processing costs amounted to a further Rs. 64,100. All the four products A, B, C and D are produced simultaneously at a single split-off point. Product C is sold immediately without further processing. The other three products are subject to further processing before being sold. It is the company's policy to apportion the costs prior to the split-off point on a suitable sales value basis.

The output, sales and additional processing costs for the past year were as follows :

Product	Output in units	Sales Rs.	Additional Processing cost Rs.
A	4,00,000	96,000	20,000
B	89,725	29,000	16,000
C	5,000	4,000	—
D	9,000	30,000	1,000

The proposals being considered by the Production Director are to sell to other processors the products immediately after the split-off point without any of the present additional processing being done. The additional processing costs of products A, B and D would either no longer be incurred or be charged to an alternative profitable use. The prices per unit to be obtained from the other processors would be :

A	Rs. 0.16
B	Rs. 0.20
C	Rs. 0.80
D	Rs. 2.50

(I.C.M.A., Pt. IV—Adapted)

ANSWER :

The report will be based on the following calculations :

(a) Joint cost at the point of split-off :	
Raw materials	Rs. 33,500
Initial processing	Rs. 64,100
	<hr/>
	Rs. 97,600

This is apportioned to the four joint products on the basis of sales less further processing costs :

Product A :	$\frac{97,600}{1,59,000 - 37,000} \times (96,000 - 20,000)$	= Rs. 60,800
B :		= Rs. 10,400
C :		= Rs. 3,200
D :		= Rs. 23,200
		<hr/>
		Rs. 97,600

Statement of profit and loss

	A	B	C	D	Total
	Rs.	Rs.	Rs.	Rs.	Rs.
Apportioned cost	60,800	10,400	3,200	23,200	97,600
Additional processing cost	20,000	16,000	—	1,000	37,000
	<u>80,800</u>	<u>26,400</u>	<u>3,200</u>	<u>24,200</u>	<u>1,34,600</u>
Sales	96,000	29,000	4,000	30,000	1,59,000
Profit	<u>15,200</u>	<u>2,600</u>	<u>800</u>	<u>5,800</u>	<u>24,400</u>

(b) If the products are sold at the point of split-off without further processing, the position will be :

Product A : 4,00,000 units × Re. 0.16 = Rs.	64,000
B : 89,725 units × Re. 0.20 = Rs.	17,945
C : 5,000 units × Re. 0.80 = Rs.	4,000
D : 9,000 units × Rs. 2.50 = Rs.	22,500

Total Sales	<u>Rs. 1,08,445</u>
Total Costs	<u>97,600</u>

Profit reduced to	<u>Rs. 10,845</u>
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(c) The increase in the sale value after processing should be compared with the further processing costs, as follows :

	A	B	C	D	Total
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales value after further processing	96,000	29,000	4,000	30,000	1,59,000
Sales value at Split-off	<u>64,000</u>	<u>17,945</u>	<u>4,000</u>	<u>22,500</u>	<u>1,08,445</u>
Difference	32,000	11,055	—	7,500	50,555
Further processing cost	<u>20,000</u>	<u>16,000</u>	<u>—</u>	<u>1,000</u>	<u>37,000</u>
Margin	<u>12,000</u>	<u>(—) 4,945</u>	<u>—</u>	<u>6,500</u>	<u>13,555</u>

It follows from the above that A and D should be further processed and B and C should be sold at the point of split-off without further processing. If this be done, the position will be as follows :

Sales value less further processing cost	
Product A : Rs. 96,000 — Rs. 20,000 = Rs.	76,000
B : Rs. 17,945 — 0 = Rs.	17,945
C : Rs. 4,000 — 0 = Rs.	4,000
D : Rs. 30,000 — Rs. 1,000 = Rs.	29,000
	<u>Rs. 1,26,945</u>
Less Total joint cost	<u>Rs. 97,600</u>
Profit	<u>Rs. 29,345</u>

It will be seen from the above example that when the emergence of a product out of a joint process is inherent, the total joint cost or the cost assigned to particular products is of no relevance in deciding whether or not to further process a product. What matters is how the additional revenue compares with the additional cost and with the opportunity cost, i.e. the revenue foregone by rejecting other alternatives. For this purpose, the additional costs must include the cost of capital required for further processing. Other non-cost considerations to be kept in view in decision making are : relative demand for the various products,

the stability of such demand and existing facilities for processing of the products and their distribution and sale.

(d) *On the basis of sales less value added by completion of individual products.* In the preceding method, no allowance was made for the profit expected to be earned on costs incurred after split-off. In this method, an estimated percentage of profit is added to the cost of further completion. This reduces the assumed sales value of the production up to split-off point, to account for profit on completion cost. The method is illustrated below with the help of the figures assumed in the foregoing example. A profit of 20% on cost is assumed.

Product	Units produced	Sale price per unit	Processing cost after split-off	Value of processing (20% on process cost)	Value per unit up to split-off	Value of total production up to split-off	Percentage of apportionment	Apportioned cost up to split-off	Cost per unit up to split-off
		Rs	Rs.	Rs	Rs	Rs		Rs	Rs.
1	45,000	2 00	.40	.480	1 520	68,400	28.5	57,000	1 267
2	50 000	3 00	58	696	2 304	1,15,200	48.0	96,000	1 920
3	12,000	5 00	25	300	4 700	56,400	23.5	47,000	3 917
						2,40,000	100	2,00 000	

Although the sale value methods discussed above are simple to operate and in some cases where prices are fairly stable, these give accurate results, they suffer from the following *disadvantages* and *limitations* :—

- (i) Selling prices are mostly unrelated to cost.
- (ii) Cost is usually the main factor to determine sale price but in the sale value methods, it is the other way round, viz. the sale price determines the cost of individual products. These methods are, therefore, not always useful for determining price policies.
- (iii) Change in the sale price of one or more of the joint products without any change in method of production or in the amount of joint costs, distorts costs. In such cases, it would be expedient to adopt an average market price for each product for a particular suitable period.
- (iv) The sale value methods assume that the margin of profit is the same for all products.
- (v) Methods (a) and (b) have the added disadvantage that where further processing is done, costs incurred after split-off point are ignored. If such costs are not in the same proportion for all the products, adoption of sale value for prorating would result in unequitable apportionment. Those products on which more costs are incurred for further processing would bear a higher share of the joint costs.

2. Apportionment on the basis of physical measures of the products : Under this method, the joint cost is distributed to the products on the basis of some

suitable physical coefficient contained in the products. The physical coefficients may be expressed in weight, linear measure, volume, atomic weight, calories, etc.

For example if three products, A, B, and C are produced jointly in a process, their respective weights being 45,000 Kgs., 40,000 Kgs. and 15,000 Kgs., and if the joint cost upto the split off point is Rs. 2,00,000, the average cost per Kg. will be,

$$\frac{\text{Rs. 2,00,000}}{45,000 + 40,000 + 15,000} = \text{Rs. 2 per Kg.}$$

The cost allocation will be as follows :

	Production Kgs.	Cost Rs.
A	45,000	90,000
B	40,000	80,000
C	15,000	30,000
	<hr/> 1,00,000 Kgs.	<hr/> Rs. 2,00,000

The method is further illustrated below :

EXAMPLE 8.4.

The following data have been extracted from the books of Messrs East India Coke Co. Ltd. :—

Joint Products	Yield (in lbs.) of recovered products, per ton of coal
Coke	1,420
Coal Tar	120
Benzol	22
Sulphate of Ammonia	26
Gas	412
Total	<hr/> 2,000

The price of coal is Rs. 80 per ton. Direct labour and overhead costs upto point of split-off are Rs. 40 and Rs. 60 respectively per ton of coal.

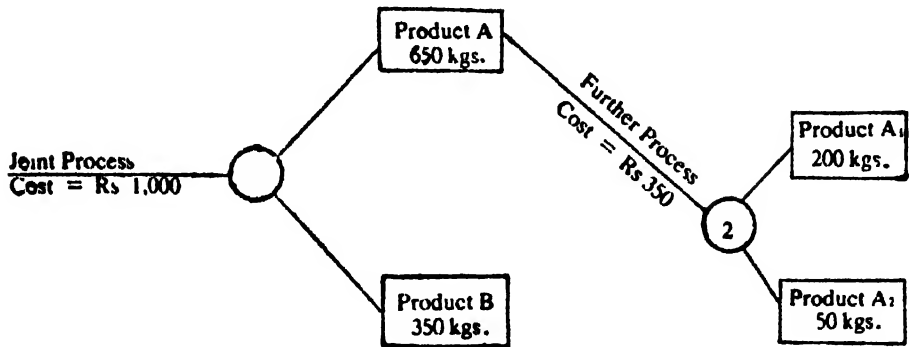
Calculate material, labour, overhead and total costs of each product on the basis of weight. (I.C.W.A., Final)

ANSWER :

	Yield (in lbs.) of recovered products per ton of coal	Percentage of total	Apportioned cost			
			Coal	Direct labour	Overhead	Total
			Rs.	Rs.	Rs.	Rs.
Coke	1,420	71.0	56.80	28.40	42.60	127.80
Coal Tar	120	6.0	4.80	2.40	3.60	10.80
Benzol	22	1.1	0.88	0.44	0.66	1.98
Sulphate of Ammonia	26	1.3	1.04	0.52	0.78	2.34
Gas	412	20.6	16.48	8.24	12.36	37.08
Total	<hr/> 2,000	<hr/> 100.0	<hr/> 80.00	<hr/> 40.00	<hr/> 60.00	<hr/> 180.00

The physical unit basis is easily applicable to processes with more than one split-off point. For example, if a process produces two products A and B at the first split-off point and after further processing of A, if two products A₁ and A₂,

are produced at the second split-off point, the product costs will be determined as follows, assuming the cost data given in the diagram below :



$$\begin{array}{l}
 \text{Product A} = \frac{\text{Rs } 1,000}{650 + 350} \times 650 = \text{Rs. } 650 \\
 \text{Product B} = \frac{\text{Rs. } 1,000}{650 + 350} \times 350 = \text{Rs. } 350 \\
 \text{Product A}_1 = \frac{\text{Rs. } 650 + \text{Rs. } 350}{200 + 50} \times 200 = \text{Rs. } 800 \\
 \text{Product A}_2 = \frac{\text{Rs. } 650 + \text{Rs. } 350}{200 + 50} \times 50 = \text{Rs. } 200
 \end{array}$$

The method is not suitable where all the output cannot be expressed in terms of the same physical unit, e.g. in the destructive distillation of coal, some product may be in the form of solid, some in liquid, and a few in the gaseous form. In such cases, apportionment may be made, if possible, by converting the physical units into a common denominator. (This has been discussed later under the technical evaluation method of apportioning joint costs) The physical unit basis is further criticised on the ground that it is illogical to assume that each physical unit of the various products should have equal value since each product may not receive similar benefits from the production process.

Another short-coming of this method is that because the unit cost of each product is an average cost, this results in identical costs being assigned to different grades or qualities of the joint products.

3. *On the basis of technical evaluation* : The underlying premise under this method, which is also known as the *Survey method*, is that the difference in costs of joint products arises due to certain qualitative and quantitative factors like quantity of materials used, labour operations performed, time taken for production, and technical difficulties in manufacture. Each of these weightage factors is assigned a point value and depending upon the extent of factors contained in it, a

product is awarded a number of points. Apportionment of joint costs is made on the basis of these point values as shown below :

Product (1)	Production units (2)	Points assigned (3)	Equivalent units [(2) × (3)] (4)	Cost per equivalent unit (Rs. 2,00,000 ÷ 8,00,000) (5) Rs.	Apportioned cost [(4) × (5)] (6) Rs.	Apportioned cost per unit [(6) ÷ (2)] (7) Rs.
1	45,000	5.00	2,25,000	0.25	56,250	1.25
2	50,000	8.80	4,40,000	0.25	1,10,000	2.20
2	12,000	11.25	1,35,000	0.25	33,750	2.81
			<u>8,00,000</u>	<u>0.25</u>	<u>Rs. 2,00,000</u>	

A variant of this method is to take one product as the base or standard. The other products are then compared with the standard in terms of the several factors and each product is expressed as a percentage of the standard.

→. *Standard allowable cost method* : This method is suitable for apportionment of the raw material cost to joint products. The profit margin, selling and distribution overhead expenses, and the conversion costs are deducted from the estimated sale value to arrive at the raw material cost. Apportionment of joint material costs is made on the basis of the sale price for each product.

The method has a limited application and may be viewed as another form of the sale value method. This is suitable for compiling material purchase variances and for determining the maximum price that may be paid for the raw materials. This is illustrated below :

EXAMPLE 8.5.

In a chemical processing factory, 1,000 kgs. of a raw material, X are used per batch of production. After processing, five joint products (one of which is a gas) are recovered and sold. Production and sale price are estimated as follows :

Product	Production per 1,000 kgs. of X	Sale Price
C-01	50 kgs.	Rs. 30 per kg.
C-02	200 kgs.	Rs. 25 per kg.
C-03	100 kgs.	Rs. 40 per kg.
C-04	300 kgs.	Rs. 15 per kg.
A-01	2,500 litres	Rs. 2 per litre

Processing cost (labour and factory overhead) is estimated at Rs. 6,410 per batch, material handling charges at Rs. 680 per 1,000 kgs. of raw material and selling and distribution overhead at 10 per cent of sales. The factory expects a return of 10 per cent on the turnover.

One per cent of the raw material is retrieved at the end of the process at original cost (without handling charges) and is used for the next batch of production. The balance of raw material unaccounted for is invisible waste.

State what should be the purchase price per kg. of X in order to achieve the above result, and compute the unit cost of sales of each of the joint products on the basis of their sale value.

(I.C.W.A., Final)

ANSWER :

Sales	Rs. 20,000	
Less Profit	2,000	
Cost of sales	18,000	
Less Selling and distribution cost	2,000	
Factory cost	16,000	
Less Process cost		6,410
Less Material handling		680
Cost of material		Rs. 8,910
Cost of material, i.e. purchase price per kg.		$\frac{\text{Rs. 8,910}}{(1,000 - 10)} = \text{Rs. 9}$

Apportionment of Joint Cost of Sales

Product	Quantity produced kgs.	Sale price per kg Rs.	Total sale Rs.	Prorated cost Rs.	Cost per unit Rs.
C-01	50	30	1,500	1,350	27
C-02	200	25	5,000	4,500	22.5
C-03	100	40	4,000	3,600	36
C-04	300	15	4,500	4,050	13.5
A-01	2,500 (litres)	2 (per litre)	5,000	4,500	1.8
			Rs. 20,000	Rs. 18,000	

The prorated cost is worked out as follows :

C-01	$\frac{\text{Rs. 18,000}}{20,000} \times 1,500$	Rs. 1,350, and similarly for the other products.
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5. *On the basis of marginal cost and contribution* : In this method, the marginal cost of the joint process or operation is apportioned to individual products on the basis of a suitable physical unit, and the fixed cost on the basis of the marginal contribution made by each of the products. The method is illustrated below :

	Products				
		1	2	3	
Sales units		2,500	2,000	3,000	
Sales rate		Rs. 2.00	Rs. 1.50	Rs. 1.20	
	Total				
	Rs.	Rs.	Rs.	Rs.	
Sales value	11,600	5,000	3,000	3,600	
Marginal cost	7,500	2,500	2,000	3,000	Prorating on the basis of units
Contribution	4,100	2,500	1,000	600	
Fixed cost	2,460	1,500	600	360	Prorating on the basis of marginal contribution
Total cost	9,960	4,000	2,600	3,360	

The main *advantage* of the marginal contribution method is that the benefits of the marginal costing system for making policy decisions may be derived in case of joint costs also. For example, useful information may be obtained for taking

a decision on maximisation of profit by suitable re-arrangement of the product mix.

The example given below illustrates the results obtained under three different methods of apportionment of joint costs.

EXAMPLE 8.6.

"If . . the products are . . truly joint products, the cost of the process can be applied to these products :

(1) On the basis of the weight or other physical quantity of each product.
 (2) In respect of the marginal cost of the process on the basis of physical quantities, and in respect of the fixed costs of the process on the basis of the contribution made by the various products.

(3) On the basis of the selling values of the different products."

(A Report on Marginal Costing (Appendix II), I.C.M.A.)

Discuss the above statement, using for purposes of illustration, the following figures in respect of the joint production of A and B for a month :

				Rs.
Total costs :	Direct materials	..	..	2,600
	Direct labour	..	..	1,000
	Variable overheads	..	..	800
	Fixed overheads	..	..	2,200
Sales A	100 tonnes	Rs. 60 per tonne		
.. B	120 tonnes	Rs. 20 per tonne		

(I.C.M.A.. Final—Adapted)

ANSWER :

Apportionment of joint costs under the three methods is as follows :

					Rs.
Sales	..	..	..	..	8,400
Direct material	..	..	..	..	2,600
Direct labour	..	..	..	..	1,000
Variable overhead	..	..	..	..	800
Marginal cost	..	..	..	..	4,400
Marginal contribution		..	..	..	4,000
Fixed cost	..	..	..	..	2,200
Profit	..	..	..	..	1,800

Total cost—Rs. 6,600

(i) *On the basis of weight :*

	Production (Tonnes)	Prorated cost (100 : 120)	Profit
A	100	Rs. 3,000	Rs. 3,000
B	120	Rs. 3,600	(—) Rs. 1,200 (Loss)
		Rs. 6,600	Rs. 1,800

(ii) *Marginal cost on the basis of weight and fixed cost on the basis of contribution :*

	Production (Tonnes)	Sales	Prorated marginal cost (100:120)	Marginal contribution	Prorated fixed cost	Profit
		Rs.	Rs.	Rs.	Rs.	Rs.
A	100	6,000	2,000	4,000	2,200	1,800
B	120	2,400	2,400	Nil	Nil	Nil
			Rs. 4,400		Rs. 2,200	Rs. 1,800

(iii) *On the basis of sales :*

	Sales Rs.	Prorated cost Rs.	Profit Rs.
A	6,000	4,714	1,286
B	2,400	1,886	514
		<hr/> Rs. 6,600	<hr/> Rs. 1,800

Accounting of By-products. Accounting of by-products takes into consideration their two basic characteristics, viz. (i) that a by-product is relatively less important than joint products and (ii) that it has a fairly steady market value which is not as significant as the main or major products but is definitely much more than that of scrap or waste. Such value is often acquired after incurring additional costs after the point of split-off unlike scrap which may be sold outright as it arises. The accounting consists of two steps ; firstly, to determine or assign costs to the by-product and secondly, to deduct the cost so assigned from the total costs, in order to arrive at the unit cost of the major product. If there are several major products, the residual cost, i.e. the total cost less the assigned cost of the by-product is further apportioned to the joint products in accordance with any of the methods discussed earlier. Another method of accounting of by-products is to credit the sale of by-products to profits, no attempt being made to cost the by-product or to credit its value to the cost of the main product. This method is similar to one of the methods used for the accounting of scrap and some accountants prefer it, particularly when the by-product is sold as it is, without further processing after split-off.

The various methods of apportioning or assigning costs of by-products will be discussed under two heads, viz. (i) non-cost methods which take into account only the sale value of the by-product, and (ii) cost methods which attempt to apportion the joint costs incurred up to the split-off point to the by-product as fairly and accurately as possible. In the non-cost methods, sale of the by-products is credited to Profit and Loss Account or to the main product, and the inventory is assigned an independent value. In the cost methods, the inventory valuation also is based on the allocated joint costs.

The following methods of by-product accounting will be discussed :

Non-cost or Sale value methods

- (a) Other income method (credit to Profit and Loss as other income or as additional sales revenue)
- (b) Credit of sale value to total costs (cost of production or cost of sales)
- (c) Credit of sale value less administration, selling and distribution expenses
- (d) Credit of sale value less costs incurred after split-off
- (e) Reverse cost method.

Cost methods

- (f) Opportunity cost (or Replacement cost) method
- (g) Standard cost method
- (h) Apportionment on suitable basis.

(a) *Other income method.* In the other income method of by-product accounting, the sale value of the by-product is credited to the Profit and Loss Account and no credit is taken in the cost accounts. The credit to the Profit and Loss Account is treated either as miscellaneous income or as additional sales revenue, as illustrated below :

	By-product taken as miscellaneous income	By-product taken as sales revenue
Sales (main product) 2,000 units at Rs. 2 per unit	Rs. 4,000	Rs. 4,000
By-product sales	--	Rs. 300
		<hr/> Rs. 4,300
Cost of sales :		
Total production cost, 2,500 units at Rs. 1.40 per unit	Rs. 3,500	
Less Closing stock, 500 units at Rs. 1.40 per unit	Rs. 700	
	<hr/> Rs. 2,800	<hr/> Rs. 2,800
Gross profit	Rs. 1,200	Rs. 1,500
Administration and Marketing expenses	Rs. 500	Rs. 500
	<hr/> Rs. 700	<hr/> Rs. 1,000
Operational profit		
Other income :		
Sale of by-product	Rs. 300	
	<hr/> Rs. 1,000	<hr/> Rs. 1,000
Net profit		

Obviously, the value of the by-product does not appear in the Balance Sheet and the stock is carried as memorandum quantity only. The method may be applied, (a) when the value of the by-product is not very important or when it cannot be determined on a rational basis without incurring a lot of clerical expenditure, and (b) the action in not affording credit to cost does not significantly affect the cost of the parent or main product. The method has, therefore, a limited application and it suffers from the following defects :—

- (i) Practically speaking this is no method of costing. This is also known as *Zero Cost method*.
- (ii) As there is a time lag between sales and production, the accounting is inaccurate. By-products may arise in one accounting period but credit may be given in another. This distorts the profits between one period and another.
- (iii) By-product not sold is maintained at nil value. This vitiates valuation of closing stock.
- (iv) There is no control over stock of by-products. No one bothers whether any credit is given or whether the physical stock is properly accounted for or adequately taken care of.
- (v) The stock valuation of the main product or joint products is inflated.

The other methods in which the sale value of the by-product is credited to the cost of production of the main product may be classified as follows :—

(b) *Crediting sales value to total cost.* The sale proceeds of the by-product are treated as deductions from the total costs. The sale value is deducted either

from the production costs or from the cost of sales. The methods are illustrated below :

Credit to cost of production :

Sale (main product), 2,000 units at Rs. 2 per unit		Rs. 4,000
Cost of sales		
Total production cost, 2,500 units at Rs. 1 40 per unit	Rs. 3,500	
Less Value of by-product	Rs. 300	
	<hr/>	
Net production cost	Rs. 3,200	
Less Closing stock, 500 units at Rs. 1.28 (Rs. 3,200 ÷ 2,500)		
per unit	Rs. 640	
	<hr/>	Rs. 2,560
Gross profit		Rs. 1,440
Administration and marketing expenses		Rs. 500
		<hr/>
Net Profit		Rs. 940

Credit to cost of sales :

Sales (main product), 2,000 units at Rs. 2 per unit		Rs. 4,000
Cost of sales		
Total production cost, 2,500 units at Rs. 1 40 per unit	Rs. 3,500	
Less Closing stock, 500 units at Rs. 1 40 per unit	Rs. 700	
Less Value of by-product	Rs. 300	
	<hr/>	Rs. 2,500
Gross profit		Rs. 1,500
Administration and marketing expenses		Rs. 500
		<hr/>
Net Profit		Rs. 1,000

The sale value method has the *disadvantage* that the costs of the main products fluctuate with the varying prices of the by-product from period to period. This may, however, be obviated by using a standard selling price for the by-product.

(c) *Crediting selling value less administration, selling and distribution expenses.* In this method, a portion of the administration, selling and distribution overhead incurred for disposing of the by-product is deducted from the sale value for credit to process account.

(d) *Crediting selling value less the costs incurred on by-product after split-off point.* In certain cases, it becomes necessary to perform some further operations on the by-product after the split-off point, in order to make it saleable. Credit is given to the process account for sale value less the cost after split-off point.

	Rs
Joint cost at split-off (apportioned to main products)	15,000
Add subsequent costs (on main-products)	800
	<hr/>
Total cost (main products)	15,800

Total cost (main products)	Rs.	15,800
Deduct By-products :		
Sale value	Rs.	1,000
Less Further cost after split-off		200
Less Selling and distribution cost		100
		<u>700</u>
Net cost of production (main products)	Rs.	<u>15,100</u>

Another illustration to explain this method is given below :

EXAMPLE 8.7.

Metal Finishes Limited manufactures product X, a rust binding preparation, which is sold at Rs. 4.45 per kg.

Batch production of product X begins in the Blending department. For the month under review the following materials were issued to the Blending department :

	Kgs.	Price per kg.
M ₁	10,000	Rs. 1.00
M ₂	4,000	Rs. 1.10
M ₃	1,000	Rs. 0.50

The materials after blending go to the Heat Treatment department where there is a 10% loss by evaporation. The 90% which emerges from the extended heat treatment passes by conveyor belt through a complex cooling department (C).

Under existing production conditions, 80% of the cooled mixture is then siphoned from the containers and is poured into metal canisters in the Packing department (P) after which it is ready for sales despatch. The 20% residue, after the siphoning, is sold as a by-product Q at Rs. 0.40 per kg.

Processing costs per kg. of departmental input for the month were :

Department	Rs.
Blending	0.35
Heat treatment	0.40
Cooling	0.45
Packing	0.45

All packing costs are to be treated as variable.

However, by varying the temperature gradations and the length of the cooling period, the residue may be as high as 30% but it is never less than 20% of the Cooling department output.

Research has shown that by-product Q could be further processed for sale at the greatly increased price of Rs. 4.80 per kg. if further capital were invested to provide an additional department. The new by-product QP could be produced by adding half a kg. of Material Z to each kg. of residue from department C, but the subsequent processing has a 40% loss. Material Z costs Rs. 0.50 per kg. The new department would incur variable processing costs of Rs. 1.10 per kg. of all input and a fixed departmental cost of Rs. 4,674 per month.

You are required to present tabulations covering the alternative operations of Metal Finishes Limited for one month to show the total production and gross profit when :

- the quantity of Q is 20% of the mixture from department C (cooling department) ;
- the quantity of Q, further processed to product QP is .

(i) 20% of the mixture from department C.

(ii) 30% of the mixture from department C.

(I.C.M.A., Pt. IV—Adapted)

ANSWER :

Cost up to split-off point :

Blending

Direct materials	Kgs	Per unit	Rs.
M ₁	10,000	Rs 1 00	10,000
M ₂	4,000	Rs 1 10	4,400
M ₃	1,000	Rs 0 50	500
	<u>15,000</u>		<u>14,900</u>
Labour and overhead		Rs. 0 35	5,250
			<u>20,150</u>

Heat treatment

Labour and overhead		Rs 0 40	6,000
10% Loss	1,500		
	<u>13,500</u>		<u>26,150</u>

Cooling

Labour and overhead		Rs 0 45	6,075
	<u>13,500</u>		<u>32,225</u>

Cost before split-off

Output of by-product

	[a] kgs	[b(i)] kgs	[b(ii)] kgs.
Total from processes	13,500	13,500	13,500
Percentage of by-product	(20)	(20)	(30)
By-product weight	2,700	2,700	4,050
Add Material Z (50%)	—	1,350	2,025
	<u>2,700</u>	<u>4,050</u>	<u>6,075</u>
Less Process loss (40%)	—	1,620	2,430
	<u>2 700</u>	<u>2 430</u>	<u>3 645</u>

Valuation of by-product at split-off stage .

	[a] Rs	[b(i)] Rs	[b(ii)] Rs.
Sale price	0 40	4.80	4.80
	<u>1,080</u>	<u>11,664</u>	<u>17,496</u>
Less Fixed cost	—	4,674	4,674
	<u>1,080</u>	<u>6,990</u>	<u>12,822</u>
Less Processing cost	—	4,455	6,682.5
		(4,050 × Rs. 1.10)	(6,075 × Rs 1.10)
	<u>1,080</u>	<u>2,535</u>	<u>6,139.5</u>
Less Cost of material Z	—	675	1,012.5
		(1,350 × Rs. 0.50)	(2,025 × Rs. 0.50)
Realisable value	<u>1,080</u>	<u>1,860</u>	<u>5,127</u>

Total Production Cost and Gross Profit :

	[(a)]		[b(i)]		[b(ii)]	
	kgs.	Rs.	kgs.	Rs.	kgs.	Rs.
Before split-off	13,500	32,225	13,500	32,225	13,500	32,225
Less by-product	2,700	1,080	2,700	1,860	4,050	5,127
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	10,800	31,145	10,800	30,365	9,450	27,098
Add packing Cost (Re. 0.45)		4,860		4,860		4,252.5
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Total cost of production	10,800	Rs. 36,005	10,800	Rs. 35,225	9,450	Rs. 31,350.5
Sale at Rs. 4.45		48,060		48,060		42,052.5
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
Gross profit		Rs. 12,055		Rs. 12,835		Rs. 10,702

(e) *Crediting selling value less profit (Reverse Cost method).* The method is based on the view that the sale value of the by-product contains an element of profit, credit for which should not be given to the process and only the costs should be entered in the process accounts. This is also called the *Reverse* or *Reversal Cost* method as the cost is derived from the sale price by working backwards. As actual profit is not available, a suitable percentage of profit is assumed. The cost of the by-product is obtained by deducting from the estimated sale value, the assumed amount of profit and the additional estimated cost, if any, incurred in processing the by-product after split-off point, as shown below :

	Main Product	By-Product
Total production costs 10,000 units at Rs. 4 per unit	Rs. 40,000	
Estimated market value 2,000 units at Rs. 2 per unit		Rs. 4,000
Estimated gross profit, 20% of selling price	Rs. 800	
Estimated Admn. and Marketing expenses, 2% of selling price	Rs. 80	Rs. 880
	<hr/>	<hr/>
Estimated cost after split off		Rs. 3,120
		Rs. 1,120
		<hr/>
Value to be credited to main product	Rs. 2,000	Rs. 2,000
	<hr/>	<hr/>
Net cost	Rs. 38,000	
Add back actual cost after split off		Rs. 1,000
		<hr/>
Total		Rs. 3,000
		<hr/>
Unit cost	Rs. 3.80	Rs. 1.50

The following example further illustrates this method :

EXAMPLE 8.8.

In manufacturing the main product A, a company processes the resulting waste material into two by-products M_1 and M_2 . Using the method of working back from sales value to an estimated cost, you are required to prepare a comparative profit and loss statement of the three products from the following data :

(i) Total cost up to separation point was Rs. 1,36,000.

	A	M ₁	M ₂
(ii) Sale (all production)	Rs 3,28,000	32,000	48,000
(iii) Costs after separation	Rs	9,600	14,400
(iv) Estimated net profit percentage to sale value		20%	30%
(v) Estimated selling expenses as percentage of sale value	20%	20%	20%

(I.C.W.A., Inter)

ANSWER :

Cost at the point of separation is worked out as follows :—

	M ₁ Rs	M ₂ Rs	A Rs.	Total Rs
Sale value	32,000	48,000		
Less Net profit	6,400 (at 20%)	14,400 (at 30%)		
Less Selling expenses	6,400 (at 20%)	9,600 (at 20%)		
Less Cost after separation	9,600	14,400		
Cost up to separation	Rs. 9,600	Rs. 9,600	Rs. 1,16,800*	Rs.1,36,000

(*Rs 1,36,000 less cost of M₁ and M₂, Rs. 19,200)

Comparative profit and loss account

	Total Rs	A Rs	M ₁ Rs.	M ₂ Rs.
Cost up to separation	1,36,000	1,16,800	9,600	9,600
Cost after separation	24,000	—	9,600	14,400
Total cost	1,60,000	1,16,800	19,200	24,000
Sales	4,08,000	3,28,000	32,000	48,000
Gross profit	2,48,000	2,11,200	12,800	24,000
Less selling expenses at 20% of Sales	81,600	65,600	6,400	9,600
Net profit	Rs. 1,66,400	Rs. 1,45,600	Rs. 6,400	Rs. 14,400

In the above methods and in the cost methods which follow, whenever values or costs are assigned to by-products, the closing stock may be exhibited in the Balance Sheet at the assigned value. This procedure has to be followed for the sake of convenience although sometimes, it may violate the principle of cost or market price whichever is lower for the valuation of closing stock.

(f) *Opportunity Cost method.* Also known as *Replacement cost method*, this method is applicable when by-products are utilized in the undertaking itself as material for some other process or for such other purpose. The necessity for purchase of the products from outside suppliers is thus avoided. The opportunity cost, i.e. the cost which would have been incurred had the by-product been obtained from outside sources is taken as the cost of the by-product. In the cotton spinning industry, for instance, cotton waste which arises as a by-product in processing for fine yarn may be utilized in the cotton mix for producing lower counts of yarn. Credit for the cost of the waste is given to the process at the purchase price which the mill would otherwise have paid. Similarly, the blast furnace gas and coke oven gas in the steel industry are re-used for the open hearth, and waste heat from the furnaces is used to generate steam. The costs of the gas and the waste heat are credited to the relevant processes at an assigned value based on the purchase or replacement cost of fuel yielding equivalent heat units.

In certain processes, any increase in the quantity of a by-product results in a corresponding decrease in the output of the main product. In such cases, the cost of the by-product should be taken to be identical with that of the main product. In fact, the by-product under such circumstances becomes a joint product.

(g) *Standard Cost method.* The by-product is assigned a standard value and credit is given to the process account at this value. As the credit on account of by-product cost would be a steady figure, this method enables an effective control to be exercised over the cost of the main product.

(h) *Apportionment on a suitable basis.* This method is similar to the one adopted for apportionment of costs of joint products. The joint cost of the main products and the by-product up to the split-off point is apportioned between the main products and the by-product by any of the methods discussed under the section for accounting of joint products. Obviously, some weightage has to be given for the difference in the importance and stature of the main products and the by-products.

Objectives of Joint Cost Analysis. Analysis of joint costs and accounting of joint products and by-products serve the following purposes :

- (i) Correct collection and compilation of process costs.
- (ii) Determination of profit and loss on each line.
- (iii) Study of the effect on costs and profits of increase and decrease in production of joint products.
- (iv) Determination of the pattern of production and the most profitable product mix.
- (v) Use of data for price fixation.
- (vi) Determining the profitability of selling products and by-products as they come out at the split-off point vis-a-vis selling only after further processing.
- (vii) Marginal contribution analysis.

Joint cost analysis has, however, certain *problems* and *limitations*. These are :

- (i) Apportionment of joint costs is mainly arbitrary ; no two methods give the same results and the 'true' costs of individual products cannot be arrived at.
- (ii) Several assumptions are made in the allocation of joint costs. Unless these assumptions are kept in view, the information presented would be incomplete and even misleading.
- (iii) The use of such arbitrary methods makes inter-firm comparison difficult.
- (iv) Where by-product has no appreciable sale value, it is not worthwhile analysing the joint costs ; the by-product may be treated as scrap.
- (v) Allocation of joint costs is not relevant in management decision making. Decisions relating to joint costs may be of two types, viz. (i) whether to produce the joint products at all, and (ii) whether to process a joint product beyond split off point. In the former situation, the decision maker has the choice to produce all the joint products or to produce nothing at all. In the latter case, decision will be taken by comparing the incremental revenue after split off point with the additional cost incurred after separation. In either case, the allocation of joint costs does not come into the picture.

EXAMINATION QUESTIONS

1. (a) Enumerate the sources of wastage in a manufacturing undertaking with which you are familiar.
(b) Indicate the principles upon which such losses should be treated in the Cost Accounts. *(I.C.W.A., Inter)*
2. Distinguish between 'spoilage' and 'scrap'. In a Heavy Engineering Factory a lot of scrap occurs in the Process Department. Each man handles several jobs in a day. It is not possible to identify the scrap by jobs. All the scrap is collected every day and stored in dumps and disposed of. You are required to suggest any suitable procedure for accounting of this scrap and its proper credit to the jobs, bearing in mind that the percentage of scrap arising in certain jobs is comparatively high. *(I.C.W.A., Final)*
3. The salvage yard of a factory contains large stock of spoiled materials, defective production, scrap and waste. What advice would you give for the managerial control of these items? Suggest how these should be treated in accounts. *(I.C.W.A., Final)*
4. What do you understand by normal and abnormal waste of materials during process of manufacture? State briefly how each should be treated in Cost Accounts. *(I.C.W.A., Inter)*
5. (a) Design a scrap (and rectification) report for a factory comprising three production departments.
(b) State which accounts should be charged with the different classes of scrap made. *(I.C.W.A., Inter)*
6. Differentiate between products and by-products. Discuss the methods normally adopted for costing by-products.
At what point of time would you take into account value of by-products in the books of the company? Give reasons. *(I.C.W.A., Final)*
7. What is the difference between normal spoilage and abnormal spoilage? How are these treated in the process accounts? *(I.C.W.A., Final)*
8. Spoiled products of some industries could be sold in the market as 'seconds' or 'thirds'. How would such spoiled/defective products be valued? *(I.C.W.A., Final)*
9. A system of job order costing is operated at a small engineering works where part of the production is defective but capable of rectification.
Design a sheet to record an item of defective production, and the necessary variable cost additions for rectification. Show how the figure obtainable from the record would be journalised. *(I.C.M.A., Pt. IV)*
10. Components found defective in the course of manufacture can be rectified, salvaged for alternative use, or scrapped. Outline the steps to recover costs incurred on these rejects from persons responsible for the same. How will the cost involved be collected and controlled? *(I.C.W.A., Final)*
11. In an industrial organisation, production is inspected at the different stages of manufacture and defectives are reported. The defectives are subsequently rectified by requisitioning additional materials and expending additional labour. Assuming that job costing procedure is followed in the organisation, you are required to—
(a) draft a suitable form to record defective production,
(b) draft a rectification order,
(c) state what cost aspects should be considered before issue of a rectification order, and
(d) give journal entries for recording the issue of materials and expenditure of labour and overheads for rectification. *(I.C.W.A., Final)*
12. In the manufacture of a certain product, a number of by-products arise. Due to certain external factors, one of the by-products increases very much in value and as a result becomes the main product. What costing problems is this likely to create and how would you tackle them? *(I.C.W.A., Final)*
13. Distinguish between joint products and by-products. Under the following circumstances how would you treat by-product in cost accounts?
(i) when by-products are processed to dispose of waste materials more profitably.
(ii) when by-products are processed to utilize idle plant. *(I.C.W.A., Final)*

14. Explain the distinction between co-products, by-products, and waste. The methods of accounting of by-products can be grouped under two broad types : non-cost methods which do not attempt to cost the by-products and cost methods which allocate costs to the by-products. Outline four methods of valuing and costing by-products selecting two methods from each of the types mentioned above. *(I.C.W.A., Final)*
15. The process of manufacture of Caustic Soda involves production of Hydrogen and Chlorine and the production of one tonne of Caustic Soda results in production of 887 Kg. of Chlorine and 24 Kg. of Hydrogen. All these three products are normally utilised internally by a company producing caustic soda. That company however occasionally finds it cannot use a part of its Chlorine and/or Hydrogen production. On those occasions the excess Chlorine is drained out, while Hydrogen is liberated in the atmosphere.

The Cost Accounting (Caustic Soda) Records Rules require these three products should be valued at cost.

List out three different methods of allocation of joint costs to these products.

(I.C.W.A., Final)

16. Discuss three methods of allocating joint costs? What are their limitations? *(I.C.W.A., Final)*
17. In a large steel plant, three batteries of coke ovens form one of the main limits for production of coke. Important by-products like Tar, Benzol, Toluene, Xylene, Solvent Naptha and Napthalene are recovered from the coke oven gases in the by-product recovery plants and sold in the market. The residual coke oven gas (a part of which is used as a fuel in the furnaces in the Steel plant) is supplied to an adjacent Fertilizer Factory specially built for the utilization of the coke oven gas. The Steel Plant is inclined to treat the gas as a co-product and charge a high price while the Fertilizer Factory considers that the gas being more or less waste gas so far as the Steel Plant is concerned, should be charged for only at a nominal price.

What costing principles would you apply for pricing the coke oven gas?

(I.C.W.A., Final)

18. In making a product, a valuable by-product is made. This by-product can be sold in the form in which it is produced, or can be subjected to further processes, after which it is saleable at a higher price.

Explain how you would present information to management to show the best way of dealing with the by-product *(I.C.W.A., Final)*

19. In the manufacture of carton boxes of type A, off-cuts of boards of different sizes arise. Some of these off-cuts are used in the manufacture of smaller carton boxes and the rest are of no value. Explain with assumed figures how you would account for the value of these off-cuts in costs. *(I.C.W.A., Inter)*

20. 'By-product costing and pricing in a process industry is basically a subjective process or a deduction from external market prices'. Do you agree?

In auditing of the costs of by-products, what precautions must be taken by a Cost Auditor to ensure that the costing and pricing method is scientific and objective as far as possible? *(I.C.W.A., Final)*

21. What are the problems involved in accounting for joint product costs? Suggest methods for equitable allocation *(I.C.W.A., Final)*

22. A company manufactures a single product, the standard costs of which are as follows : Direct materials £5 each, Direct wages .8hrs at 5s. per hour.

Overheads are absorbed at the rate of 17s. 6d per hour and in a normal month will amount to £7,000, of which £4,000 is fixed overhead. During this period 1,000 units will be produced and sold as follows : 900 'firsts' at £15 each ; 50 'seconds' at £10 each ; 50 'thirds' at £5 each.

Present information to management showing the loss due to the production of inferior units. By re-processing the inferior units, taking the full reprocessing time of a further 8 hours, and adding further materials costing £2 per unit, the 'seconds' and 'thirds' can be converted into 'firsts'.

Present information to management, and make recommendations on this course of action. *(I.C.W.A., Part IV)*

23. A textile company has a department which concentrates upon one style of garment which is re-designed annually. Since high-grade production is aimed at, a proportion of the output, usually 20% is sold without the brand name, being sub-standard. A further 2% has no value except for certain pieces of salvage of material, usable for trimming.

The figures for a batch of 100 were as follows :

		£	s	d
Direct materials	..	3	0	0 per garment
Direct wages	..	1	10	0 per garment
Variable overhead	..	2	0	0 per garment
Fixed overhead	..	150	0	0 (total)
Output :				
First grade 78 garments . sales value	..	15	0	0 each
Sub-standard 20 garments sales value	..	8	0	0 "
Scrap 2 garments value	..	10	0	0 "

No difficulty is experienced in using salvaged materials from scrap up to 5% but beyond this level, scrap is virtually of no value. Sickness and holiday absence make the engagement of temporary staff necessary. The employment of temporary staff increase sub-standard output to 30% and scrap to 7%. Fixed overhead is unaffected. Using the figures given, show how the joint costs would be allocated

Determine profits on first grade and sub-standard output in (a) normal sub-standard garments

What advice would you give to management? (I.C.M.A., Pt. IV)

24. A company produces three joint products A, B and C by the operation of a process.

The standard costs for a period are as follows

Input	Materials 600 tons at £20 per ton
	Labour at £5 per ton of input
	Overhead at 200% on labour
Output	400 tons products A at £30 per ton
	100 tons product B at £40 per ton
	5,000 gallon product C at £1 per gallon
	Product A is sold at a price of £35 per ton

Product B is passed to a second process, in which labour costs are £10 per ton of input and overhead is at 200% on labour. The output is 98 tons of Product M which is sold at £80 per ton.

Product C is passed to another process in which labour costs are 4s per gallon, and overhead is again at 200% on labour. The output is 50 tons of Product N which is sold at £200 per ton. Present figures to management to show the profitability of operating the processes. All process losses should be regarded as normal

(I.C.M.A., Pt. IV)

25. The estimated market value of the by-product resulting from a production process is Rs. 1,200 at the time of its separation from the main product. The by-product is further processed at an expenditure of Rs. 2,000 for materials, Rs. 3,500 for wages and Rs. 2,100 for factory overhead charges.

After having been processed, the by-product is sold for Rs. 12,000

Give the necessary journal entries to record the above transactions (M.Com., C.U.)

26. A factory producing articles P also produces a by-product Q which is further processed into finished product. The joint cost of manufacture is given below :

Material	..	..	Rs. 5,000
Labour	..	..	Rs. 3,000
Overheads	..	..	Rs. 2,000
			Rs. 10,000

Subsequent costs are given below :

	P	Q
Materials	3,000	1,500
Labour	1,400	1,000
Overheads	600	500
	<u>Rs. 5,000</u>	<u>Rs. 3,000</u>

Selling prices are :

P—Rs. 16,000

Q—Rs. 8,000

Estimated profits on selling prices are 25% for P and 20% for Q.

Assume that selling and distribution expenses are in proportion of sales prices.

Show how you would apportion joint costs of manufacture and prepare a statement showing cost of production of P and Q. (C.A., Inter)

27. Of the three joint products A, B and C, C has the following cost composition :—

			Per unit
			Rs.
Marginal cost	..	..	10
Fixed cost	..	..	8
After point of separation :			
Marginal	..	..	4
Fixed cost	..	..	3
Total cost	..		<u>Rs. 25</u>

C has no realisable value unless it goes through 'after point of separation' process. At the finished stage it can be sold at Rs. 12 per unit and no more. As this does not even cover the marginal cost, management is desirous of discontinuing product C. What would be your advice? Give reasons. (I.C.W.A., Final)

28. Two joint products A and B emerge at the end of Process S. Both these products can be sold at the split off stage at Rs.10 per Kg. and Rs.12 per Kg. respectively. 10% of the input into Process S turns out to be by-product X which can be sold at the split off stage at a price of Re. 1 per Kg. less packing, forwarding and freight amounting to 60 paise per Kg. Product A can also be processed further at Process T whereupon it becomes product ALX. Product ALX can be sold at Rs. 20 per Kg. By-product Y emanates at Process T and it can be sold at Rs. 1.80 per Kg. less packing, forwarding and freight amounting to 80 paise per Kg. 5% of input of Process T turns out to be by-product Y.

Estimates of production and costs for a year are as under :

Production : Product ALX—2,09,000 Kgs.; Product B—3,65,000 Kgs.

Costs :	Process S Rs.	Process T Rs.
Raw Materials Rs. 4 per Kg.		
Direct materials	4,00,000	1,00,000
Direct wages	7,00,000	2,00,000
Variable overheads	8,00,000	3,00,000
Fixed overheads	10,00,000	4,00,000

Selling Expenses : Product ALX—Rs. 1.50 lakh ; Product B—Rs. 6 lakh.

A competitor who has installed a modern plant for the manufacture of product ALX is able to sell ALX at a lesser price due to cost savings secured by him. As a consequence thereof, the company has to reduce the price of product ALX to Rs. 15 per Kg. However this does not affect the sales potential of the entire quantity of product A at the split off stage at the list price of Rs. 10 per Kg. If the company elects to sell Product A, the processing plant, viz. Process T can be closed down. In that event, 50% of direct wages, the entire direct material cost and variable overheads and 75% of fixed expenses of Process T can be saved. The selling expenses will also go down by Rs. 50,000 instead of Rs. 1.50 lakh for Product ALX.

- Prepare a schedule showing the apportionment of joint costs to products A and B.
- Present a statement showing the company's profitability of product A is sold at the split off stage and Process T is closed down.
- Advise the management whether further processing of product A into product ALX should be undertaken or not. Show the workings.
- Comment on the economics of further processing of product A into product ALX.

(I.C.W.A., Final)

CHAPTER 9

MARGINAL COSTING AND DIFFERENTIAL COSTS

Marginal Cost and Marginal Costing. Fixed and variable costs behave differently with changes in the volume of outturn ; variable costs tend to change in total with increase or decrease in the level of activity but fixed costs tend to vary with time rather than the level of output. Because of the inclusion of fixed costs in the determination of total costs, the cost per unit of a product, process, or service varies from one cost period to another in accordance with the volume of activity in each period. The necessity for the elimination of fixed costs (which are by and large, uncontrollable) in order to obviate such fluctuations in costs has given rise to the concept of marginal costing. Marginal costing is concerned basically with the determination of product costs which consist of the total cost less the fixed cost or in other words, direct materials, direct labour, direct expenses, and variable overhead. In the situation prevailing in India, where (i) most of the labour force is on day wages, (ii) a major portion of direct labour consists of dearness allowance and other fringe benefits, the nature of which is mainly fixed, and (iii) it is not possible to lay off or retrench workers according to day-to-day fluctuations in output, a portion of direct labour may, if considered proper, be treated as fixed cost and so excluded from marginal cost.

Marginal cost is defined as the amount at any given volume of output by which aggregate costs are changed if the volume of output is increased or decreased by one unit. This is subject to the condition that the fixed cost does not change with the increase in the volume. As will be seen from the example given below, marginal cost, for all practical business purposes, is measured by the variable cost (i.e. prime cost plus variable overhead) per unit of output.

If the variable cost of production is Rs. 3 per unit, the fixed cost for a specified period is Rs. 2,000, and the units of production during that period are 200 ;

Cost of production = Rs. 3×200 + Rs. 2,000 = Rs. 2,600

If in another period of the same span, 201 units are produced,

Cost of production = Rs. 3×201 + Rs. 2,000 = Rs. 2,603

Therefore, change in aggregate cost per unit, which by definition is the marginal cost, is equal to Rs. 3 (Rs. 2,603 minus Rs. 2,600). This is the same as the variable cost per unit.

Marginal cost is a constant ratio which may be expressed in terms of an amount per unit of output. On the other hand, fixed cost which is not normally traceable to particular units denotes a fixed amount of expenditure incurred during an accounting period. Fixed cost is, therefore, also called time cost, period cost, standby cost, capacity cost, or constant cost. Variable cost or marginal

cost is also termed as direct cost, activity cost, volume cost, or out-of-pocket cost.

Marginal costing is the ascertainment of marginal costs and of the effect on profit of changes in volume or type of output by differentiating between fixed costs and variable costs. Marginal costing is not a distinct method of ascertainment of costs such as the job or process costing. It is a technique applying the existing methods in a particular manner in order to bring out the relationship between profit and volume of output. Marginal costing may be so designed as to apply to all types of costing, job and process as well as historical and standard.

Several other terms in use like *direct costing*, *contributory costing*, *variable costing*, *comparative costing*, *differential costing*, and *incremental costing* are used more or less synonymously with marginal costing. The term *direct costing* is used in the U.S.A. and for all practical purposes direct costing and marginal costing mean one and the same thing. In this text, the two terms have been used interchangeably. The technique of differential incremental costing as we will see later has, however, a slightly different purpose and manner of application. The other type of costing which includes fixed costs in the calculation of product costs is known as *total costing*, *absorption costing*, or *conventional costing*.

The term direct cost should not be confused with direct costing. In absorption costing, direct cost refers to the cost which is attributable to a cost centre or cost unit (e.g. direct labour, direct material, and direct expenses including traceable fixed expenses, i.e. the fixed expenses which are directly chargeable). In direct costing (or marginal costing), factory variable overhead is taken as a direct cost while in the absorption cost method, it is indirect cost.

In the application of the techniques of marginal costing, profit is measured by the contribution of the margin to recover the fixed costs. *Contribution or gross margin* is the difference between sales and the marginal cost of sales. Marginal costing assumes that the contributions generated during a period provide a pool out of which fixed cost for that period is met ; any surplus constitutes the profit or the net margin. Contribution margin is also termed marginal income, profit contribution, variable gross margin, marginal balance or contribution to fixed costs. The main *features* of marginal costing may be summed up as follows :—

- (i) The usefulness of the marginal cost system depends upon a correct appreciation of the behaviour of costs with changes in outturn. Costs are separated into the fixed and variable elements : semi-variable (or semi-fixed) costs are also analysed into fixed and variable.
- (ii) Only the variable or marginal costs are taken into account for computing product costs. The values of stocks of finished products and work-in-progress also comprise only the variable costs.
- (iii) Fixed costs are written off during the period they are incurred and so they do not find place in product cost or in the inventories.
- (iv) Prices are based on marginal costs and marginal contribution.
- (v) Marginal costing combines the techniques of cost recording and cost reporting.
- (vi) Profitability of departments or products is determined in terms of the marginal contribution.

The table given below illustrates the method of calculation of the margin and profit under the marginal costing technique :

OPERATING STATEMENT (MARGINAL COST METHOD)

		Product A Rs	Product B Rs	Product C Rs	Total Rs
Sales		40,000	80,000	20,000	1,40,000
Less Marginal cost of goods sold .					
Direct material	Rs. 10,000	40,000	5,000	55,000	
Direct labour	Rs. 12,000	25,000	4,000	41,000	
Variable overhead*	Rs. 8,000	9,000	3,000	20,000	
		30,000	74,000	12,000	1,16,000
Marginal contribution or gross margin		10,000	6,000	8,000	24,000
Less Fixed cost for the period :					
Factory				15,000	
Administration, Selling and Distribution				5,000	
					20,000
					Net profit Rs. 4,000

*Including variable administration selling, and distribution overhead

Under the absorption costing system, the statement may appear as shown below :

OPERATING STATEMENT (ABSORPTION COSTING METHOD)

		Product A Rs.	Product B Rs.	Product C Rs	Total Rs
Sales		40,000	80,000	20,000	1,40,000
Less Cost of production					
Direct material	10,000	40,000	5,000	55,000	
Direct labour	12,000	25,000	4,000	41,000	
Variable Factory, Admin., Selling and Distribution overhead	8,000	9,000	3,000	20,000	
Fixed Factory overhead	7,000	6,000	2,000	15,000	
Fixed Administration, Selling & Distribution overhead	1,000	2,000	2,000	5,000	
		38,000	82,000	16,000	1,36,000
Net profit		2,000	(-),2,000	4,000	4,000

Comparison of Net Profit under Marginal Costing and Absorption Costing Systems. In the example given above, the net profits arrived at under marginal costing and absorption costing systems have been shown to be identical. This is because there are no opening or closing balances of finished goods or work-in-progress, i.e. there is no difference between the production and sales levels. Another example illustrating the variations in the results obtained under the two methods, when stocks are carried over from one period to another, is given below :

The basic production data are :

Normal volume of production = 13,000 units per period

Sale price Rs. 4 per unit

Variable cost Rs. 2 per unit

Fixed cost Rs. 1 per unit

Total fixed cost = Rs. 13,000 (Rs. 1 × 13,000 units, normal)

Selling and distribution costs have been omitted.

The opening and closing stocks consist of both finished goods and equivalent units of work-in-progress.

The profit and loss calculated under the two methods for the various periods are as follows :—

	<i>Period I</i>	<i>Period II</i>	<i>Period III</i>	<i>Period IV</i>	<i>Total</i>
Opening stock units	—	—	3,000	1,000	—
Production units	13,000	15,000	12,000	15,000	55,000
Sales units	13,000	12,000	14,000	16,000	55,000
Closing stock units	—	3,000	1,000	—	—
<i>Marginal Costing</i>					
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales	52,000	48,000	56,000	64,000	2,20,000
Direct costs :					
Opening stock @ Rs. 2 per unit	—	—	6,000	2,000	—
Variable cost @ Rs. 2 per unit	26,000	30,000	24,000	30,000	1,10,000
Closing stock @ Rs. 2 per unit	—	6,000	2,000	—	—
Cost of goods sold	26,000	24,000	28,000	32,000	1,10,000
Marginal income	26,000	24,000	28,000	32,000	1,10,000
Fixed cost	13,000	13,000	13,000	13,000	52,000
Profit	Rs. 13,000	Rs. 11,000	Rs. 15,000	Rs. 19,000	Rs. 58,000
<i>Absorption Costing</i>					
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales	52,000	48,000	56,000	64,000	2,20,000
Opening stock @ Rs. 3 per unit	—	—	9,000	3,000	—
Cost of production @ Rs. 3 per unit	39,000	45,000	36,000	45,000	1,65,000
Less Cost of closing stock @ Rs. 3 per unit	—	9,000	3,000	—	—
Cost of sales (actual)	39,000	36,000	42,000	48,000	1,65,000
Less Over-absorbed fixed cost	—	2,000	—	2,000	4,000
Add Under-absorbed fixed cost	—	—	1,000	—	1,000
Profit	Rs. 13,000	Rs. 14,000	Rs. 13,000	Rs. 18,000	Rs. 58,000

The following comparative features are revealed :—

- (i) In the accounting period I, the profit under both the methods is the same, there being no opening and closing stocks. Production being at the normal level, there is no under- or over-absorption of the fixed cost under the absorption costing method ; in marginal costing there is no problem of under- or over-absorption of fixed overhead.
- (ii) In the accounting period II, the absorption costing method shows a profit of Rs. 14,000 against Rs. 11,000 shown in the marginal cost statement. This is because under the former method, a portion of the fixed cost, instead of being charged against the profit for the period, is charged to the closing stock and carried over to the next period.

- (iii) In the accounting period III, marginal costing shows more profit than the absorption costing. The reason is that as sales exceed production (the closing stock is less than the opening stock), a portion of the fixed cost carried over as part of opening stock under absorption costing is charged to the products sold in the current period.
- (iv) In the accounting period IV also, the profit shown in the marginal costing system is higher because the fixed cost pertaining to the opening stock of 1,000 units now sold (there is no closing stock), is not brought over to the current accounting period.
- (v) In the long-term when sales and production volumes tend to equate, there is no difference or very little difference between the results obtained under the two methods. In the illustration given, the net profits for the four accounting periods taken together are identical under both the methods.

The position may be summarised as follows :—

- (i) With no opening or closing stock or when the inventory of finished goods does not fluctuate from period to period, i.e., when opening and closing stocks remain constant—*no difference*.
- (ii) Closing stock more than the opening stock, i.e. production exceeds sales—*higher profit in absorption costing*.
- (iii) Closing stock less than the opening stock, i.e. sales exceed production—*higher profit in marginal costing*.

The profit figure under absorption costing is reconciled with that under marginal costing as follows :

Profit under marginal costing Profit under absorption costing *less* change in fixed overhead cost in the opening and closing stocks

In accounting period II,

Profit under absorption costing	R 14,000
Less Change in fixed overhead in inventories (Rs. 9,000—Rs 6,000)	Rs. 3,000
	<hr/>
Profit under marginal costing	Rs. 11,000

Limitations of Absorption Costing. The following criticisms are levelled against the total cost method :—

- (a) Being dependent on levels of output which vary from period to period, costs are vitiated due to the existence of fixed overhead. This renders them useless for purposes of comparison and control. (If, however, overhead recovery rate is based on normal capacity, this situation will not arise.)
- (b) Carry over of a portion of fixed costs, i.e. period costs to subsequent accounting periods as part of the cost of inventory, is a unsound practice because costs pertaining to a period should not be allowed to be vitiated by the inclusion of costs pertaining to the previous period.
- (c) Profits and losses in the accounts are related not only to sales but also to production, including the production which is unsold. This is contrary to the principle that profits are made not at the stage when products are manufactured but only when they are sold.

- (d) There is no uniformity in the methods of application of overhead in absorption costing. These problems have, no doubt, to be faced in the case of marginal costing also but to a less extent because of the exclusion of fixed costs, as different assumptions made in the matter of application of fixed overhead will not arise in the case of marginal costing.
- (e) Absorption costing is not always suitable for decision making. Solutions to various types of problems of management decision making, where the absorption cost method would be practically ineffective, such as selection of production volume and optimum capacity utilization, selection of product mix, whether to buy or manufacture, choice of alternatives, and evaluation of performance, can be had with the help of marginal cost analysis. Sometimes, the conclusion drawn from absorption cost data in this regard may be erroneous leading to losses.

Applications and Merits of Marginal Costing. These are :

1. *Cost Control* : Situations arise when the profit and loss account continues to show profits even though sales decline or shows losses or reduced profit despite increase in sales. The management is unable to comprehend the results and fix managerial responsibility for the situations if data for control purposes are presented on absorption costing basis. For instance, in the illustration on Page 476, although sales increased from Rs. 48,000 to Rs. 56,000, the profit in Period III declined from Rs. 14,000 to Rs. 13,000 because of the carry over of a part of the fixed overhead incurred in Period II to Period III. In marginal costing system, profit is related only to sales and is not affected by change in the levels of inventory of finished goods. The position was, therefore, correctly brought out in the marginal cost analysis which showed a corresponding increase in the profit from Rs. 11,000 to Rs. 15,000.

Marginal costing is essentially a technique of cost analysis and cost presentation. It enables the presentation of data in a particular manner useful to various levels of management for the purpose of controlling costs. Variable overhead can be controlled at lower levels but fixed overhead may be controlled only by the top management and that too, to a limited extent only. Elimination of the fixed overhead from costs permits the concentration of efforts on the control of the variable costs. Product costs being generally limited to variable costs only, it is easier for the purpose of control to link such costs with the production achieved. The marginal contribution facilitates evaluation of performance because the results are not distorted by subjective allocation of the non-controllable costs.

In marginal costing, while attention is paid to the direct costs and the contributory margin, the fixed costs are also not lost sight of. Instead of merging the fixed costs with the cost of sales and inventories, they are collected and reported separately as a deduction from the contributory margin. This enables control being exercised over specific items of fixed cost, which though not liable to change within a short period of time, are subject to control because they can be programmed in advance.

2. *Profit Planning* ; Profit planning is the planning of future operations to attain maximum profit or to maintain a specified level of profit. The contribution

ratio or marginal ratio which is the ratio of marginal contribution to sales indicates the relative profitability of the different sectors of the business whenever there is a change in sales price, variable costs or product mix. Due to the merging of the fixed and variable costs, absorption costs fail to bring out correctly the effect of any such change on the profit of the concern.

An example illustrating profit planning with the help of marginal cost analysis is given below :

EXAMPLE 91

An umbrella manufacturer makes average net profit of Rs. 2.50 per piece on a selling price of Rs. 14.30 by producing and selling 60,000 pieces or 60% of the potential capacity. His cost of sales is :

Direct material	Rs. 3.50
Direct wage	Rs. 1.25
Works overhead	Rs. 6.25 (50% fixed)
Sales overhead	Rs. 0.50 (25% varying)

During the current year, he intends to produce the same number but anticipates that his fixed charges will go up by 10% while rate of Direct labour and Direct material will increase by 8% and 6% respectively. But he has no option of increasing the selling price. Under this situation he obtains an offer for a further 20% of his capacity. What minimum price will you recommend for acceptance to ensure the manufacturer an overall profit of Rs. 1.67 lakhs? Reason out your recommendation. (ICWA Final)

ANSWER

	Previous year		Budget for current year prior to acceptance of 20% excess orders	
	Per piece Rs	Amount Rs	Per piece Rs	Amount Rs
Sales	14.30	8,58,000	14.30	8,58,000
Variable cost				
Direct material	3.500		3.710	
Direct labour	1.250		1.350	
Variable works overhead	3.125		3.125	
Variable sales overhead	0.200		0.200	
	8.075	4,81,500	8.385	5,03,100
Contribution		3,73,500		3,54,900
Fixed cost				
Works overhead	1.87,500		2,06,250	
Sales overhead	36,000	2,23,500	39,600	2,45,850
		Rs. 1,50,000		Rs. 1,09,050

Marginal cost of additional 20,000 units (20,000 × Rs. 8.385) Rs. 1,67,700

Increased profit or contribution expected Rs. 1,67,300 Rs. 1,09,050 Rs. 58,250

Total sales price expected for 20,000 units Rs. 2,25,950

[Sales price—Marginal cost = Contribution, or Sales price—Marginal cost = Contribution
Rs. 1,67,700 + Rs. 58,250 = Rs. 2,25,950]

Sale price per unit = $\frac{\text{Rs. } 2,25,950}{20,000}$ Rs. 11.297

3. Evaluation of performance : The various business segments of a concern such as a department, a product or a product line, a market or a sales division or

territory have different revenue earning potentialities. The performance of each such sector can be brought out by means of marginal costs analysis.

An illustration which shows the performance evaluation of three different product lines is given below :

EXAMPLE 9.2.

A business produces three products A, B and C, for which the standard variable costs and standard selling prices are as follows :

	A Rs.	B Rs.	C Rs.
Direct materials	3	6	8
Direct wages	4	4	10
Variable overheads	3	5	7
Selling price (each)	18	25	48

In two successive periods, sales are as follows :

	A Units	B Units	C Units
Period 1	10,000	10,000	10,000
Period 2	20,000	13,000	5,000

The budgeted fixed overhead amounted to Rs. 1,35,000 for each period. In spite of increased sales, the profit for the second period has fallen below that of the first period.

Present figures to management to show why this fall in profit should, or should not have occurred.

(I.C.M.A., Final—Adapted)

ANSWER :

Figures presented under marginal costing procedure will be as follows :—

	Product A		Product B		Product C		Total	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
Sales (units)	10,000	20,000	10,000	13,000	10,000	5,000	30,000	38,000
Sales (value)	Rs. '000 180	Rs. '000 360	Rs. '000 250	Rs. '000 325	Rs. '000 480	Rs. '000 240	Rs. '000 910	Rs. '000 925
Direct material	30	60	60	78	80	40	170	178
Direct wages	40	80	40	52	100	50	180	182
Variable overhead	30	60	50	65	70	35	150	160
Variable cost	100	200	150	195	250	125	500	520
Marginal contribution	80	160	100	130	230	115	410	405
Fixed overhead							135	135
Net profit							Rs. 275	Rs. 270

Marginal contribution ratio, i.e. contribution expressed as % of sales :
Product A—44.4 ; Product B—40.0 ; Product C—47.9

Sales have increased by 8,000 units but the sales value has increased by only Rs. 15,000. Marginal costs have increased by Rs. 20,000 to meet cost of increased units of production, resulting in the fall of profit by Rs. 5,000.

Product C which yields the highest percentage of contribution to sales is the most profitable line. Product A comes next and Product B is the least profitable of the three. Ranking, therefore, is C, A, B.

The unsatisfactory position in period 2 is because of the unfavourable sales mix as the production of the most profitable line C has been cut down and the less profitable products A and B have been pushed up.

Note : As will be seen from the analysis below, the position as revealed under the absorption costing method would be different and also misleading.

	Product A		Product B		Product C		Total	
	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2	Period 1	Period 2
	Rs. '000	Rs. '000	Rs. '000	Rs. '000	Rs. '000	Rs. '000	Rs. '000	Rs. '000
Sales	180	360	250	325	480	240	910	925
Variable cost	100	200	150	195	250	125	500	520
Fixed cost	30	59	30	39	75	37	135	135
Total cost	130	259	180	234	325	162	635	655
Profit	50	101	70	91	155	78	275	270

(Fixed costs are assumed to be absorbed in products costs on the basis of direct wages)

Ranking in order of profitability is C, B, A.

4. *Decision making :* The major utility of marginal costing technique lies in the assistance it gives to the management in vital decision making, particularly in dealing with problems which require short-term decision where fixed costs do not count. The inclusion of fixed costs in decision making is defective for the following reasons :—

- The impact of some items of fixed costs, like supervision and inspection expenses, on various products is not uniform. The adoption of a single rate to apply to all products or product lines makes calculations incorrect.
- The selection of a suitable base and the correct level of activity for working out the fixed overhead rate presents considerable difficulties. Different conclusions may be arrived at with the use of different bases.

The basic consideration in all decision making problems is that marginal contribution is a reliable index of profitability. When alternative courses of action are available, the most suitable course will be the one which yields the highest contribution provided there are no limiting factors. Fixed costs will not normally be taken into consideration except where these are liable to change as a result of the proposed action. This is subject to the condition that there is no

limiting factor. The problems which arise when limiting factors are operating will be discussed later in this chapter.

In decision making, no problem should be considered in isolation. While looking at one area of an industrial organisation for deciding on a particular action, we cannot ignore the problems which are likely to arise in the other areas and in the organisation as a whole as the resultant effect of the action taken. This is equally true in the application of marginal contribution technique. For example, discarding a low contribution product or augmenting or adding a high contribution line may have an adverse impact on the production or sale of the other products, which would result in the loss of contribution from those products or fixing a price below the total cost may have a long lasting effect on the overall economy of the enterprise. While taking such decisions on the basis of marginal contribution, it is essential to have a *systems approach*. In other words, the possible effects of the action contemplated on the *system* as a whole should be traced and considered.

(i) *Pricing decisions* : Marginal costs being costs directly pertaining to a particular product, represent the minimum price line for that product and any sales below the marginal cost would entail a cash loss. From the point of view of pricing, the difference between absorption costing and marginal costing is that while in the former, prices are expected to cover at least the total costs so that the business may break-even, prices may be fixed under the marginal costing technique at a level above the marginal costs and sometimes under special circumstances, even below it. As a short-term measure, prices may be fixed at a level below the total costs if such a course is necessary to meet the situation arising during trade depression. The objective is that in times of recession, any marginal contribution towards recovery of fixed costs is good enough rather than not to have any contribution at all if the order is lost due to price being fixed at a higher level.

When business is slack or when the concern is facing serious competition, the excess capacity can be utilized and the products can be sold only by lowering the price. Reduction of price may be essential for several other reasons. These are :

- (i) When there is a general fall in the market price of the product.
- (ii) To maintain sales relationship and established market so that the market may not be lost to competitors in future, and advertising and other selling expenses have not to be incurred afresh when the situation improves. Sometimes the situation becomes irreversible and the market is lost for ever.
- (iii) To keep the plant and machinery in the proper gear so that they can be put into operation immediately, when required. Idle machines are liable to deteriorate and depreciate more quickly.
- (iv) To retain the surplus staff, particularly the skilled and trained staff employed. Retrenchment and lay off give rise to complicated problems, and when business returns to normal additional expenditure on recruiting and training new workers would have to be incurred.

- (v) To reduce the loss incurred in other areas due to decreased production, e.g. where large stock of raw materials remain unutilized and are likely to deteriorate.
- (vi) To obviate the costs of closing and subsequent opening of the plant.
- (vii) To maintain the market for profitable products, the sales of which are linked with products that are under consideration for price reduction.
- (viii) To push a new product in the market in which case the reduced price is in fact the 'penetration' price.

Selling even below marginal costs may sometimes be necessary when demanded by the situations referred to above.

Pricing problems arise in normal times also when, for instance, it is decided to increase the level of production and sales by reducing prices. This may be necessary in order to, (i) expand export trade and establish market for the product in foreign countries, (ii) push a new product, keeping the price as low as possible in the initial stages, (iii) dispose of a product which is likely to deteriorate quickly, or (iv) assist the sale of a joint product which is profitable. In the last mentioned case, if the price of a joint product is appreciably reduced in comparison to the price of the other joint product, the former may be relegated to the position of a by-product. Satisfactory solutions to the problems mentioned above may be obtained if costs are analysed according to the techniques of marginal costing. An example illustrating the use of marginal costs in dealing with pricing problems is given below :

EXAMPLE 9.3.

The Everest Snow Company manufactures and sells direct to consumers 10,000 jars of 'Everest Snow' per month at Rs. 1.25 per jar. The Company's normal production capacity is 20,000 jars of snow per month. An analysis of cost for 10,000 jars is given below :

					Rs.
Direct material	..	..	..	..	1,000
Direct labour	..	..	..	..	2,475
Power	..	..	..	..	140
Misc. supplies	..	..	..	..	430
Jars	..	..	..	..	600
Fixed expenses of manufacturing, selling and administration	..				7,955
Total					<u>Rs. 12,600</u>

The company has received an offer for the export under a different brand name of 1,20,000 jars of snow at 10,000 jars per month at 75 paise a jar.

Write a short report on the advisability or otherwise of accepting the offer.

(I.C.W.A., Final)

ANSWER :

Marginal contribution analysis showing the present and proposed positions is given below :

	<i>Per unit</i>	<i>Present position</i> (capacity 50%) 1,000	<i>Proposed offer</i> (capacity 50%) 10,000	<i>Total</i> (capacity 100%) 20,000
		@ Rs. 0.75 per unit		
Sales (units)				
Sales (value)	Rs. 1.25	Rs. 12,500	Rs. 7,500	Rs. 20,000
Direct materials	0.1000	1,000	1,000	
Direct labour	0.2475	2,475	2,475	
Power	0.0140	140	140	
Misc. Supplies	0.0430	430	430	
Jars	0.0600	600	600	
Variable cost	0.4645	4,645	4,645	9,290
Marginal contribution	0.7855	7,855	2,855	10,710
Fixed cost		7,955	—	7,955
Profit/Loss		Rs.(—) 100	Rs. 2,855	Rs. 2,755

The proposed offer at a lower price will increase the total marginal contribution from Rs. 7,855 to Rs. 10,710 and thus convert the loss of Rs. 100 into a net profit of Rs. 2,755. The proposal should, therefore, be accepted provided the interest on additional working capital does not wipe out the profit. Before taking a final decision, however, the following further points will be kept in view :

- (i) The extent of additional exporting costs to be incurred.
- (ii) Whether or not surplus capacity can be utilised for production of other more profitable products.
- (iii) Whether there is any risk of 'dumping', i.e. re-export by the foreign customer so that the company will be faced with competition with itself.
- (iv) Long-term effect of the reduced export price on the home market.

It may be noted that if the company does not accept the offer for the reason that it wants to maintain the long-term price structure or to avoid the risk of dumping or for any other reason, the contribution of Rs. 2,855 which is foregone is an opportunity cost.

A word of caution may be added here. Fixation of price below total costs should be made only on a short term basis. The practice of charging price below total costs, if allowed to continue for long periods is dangerous and it may make serious inroads into the economy of the concern. Further, it often becomes difficult to raise a price which has been fixed at a lower level. While it is true that variable overhead increases with the increase in the level of output, the reverse does not always hold good. Certain items of variable overhead tend to remain constant, at least for some time after production has fallen. In such a situation, the contribution margin may not give a correct picture and price decision based merely on the contribution analysis may prove to be wrong.

(ii) *Make or buy decisions* : When the management is confronted with the problem whether it would be economical to purchase a component or a product from outside sources, or to manufacture it internally, marginal cost analysis renders useful assistance in the matter. In such cases, comparison should be made between the marginal cost of manufacture of the product and the supplier's price for it. In order to select the more economical course in a situation where production facilities which cannot be utilized for the manufacture of other products is available (situation 1), the purchase cost may be compared with the marginal cost or the total manufacturing cost may be compared with the purchase price, plus the fixed cost of manufacture. It would be more profitable to manufacture than to purchase if the marginal cost is lower than the purchase price subject to the condition that the decision to manufacture does not result in substantial increase in fixed costs. It is to be noted that traceable fixed cost, i.e. the fixed cost which can be avoided by not manufacturing should, for the purpose of comparison, be treated as variable and added to the marginal cost. Let us consider the position in respect of two products as given below :

	<i>Product A</i>		<i>Product B</i>	
	(per unit)	Total (1,000 units)	(per unit)	Total (2,000 units)
Purchase price	Rs. 22	Rs. 22,000	Rs. 30	Rs. 60,000
Marginal cost	Rs. 25	Rs. 25,000	Rs. 25	Rs. 50,000
Fixed cost	Rs. 5	Rs. 5,000	Rs. 20	Rs. 40,000
Total cost	Rs. 30	Rs. 30,000	Rs. 45	Rs. 90,000

If the production capacity becomes redundant, the position will be :

	<i>Product A</i>	<i>Product B</i>
<i>If purchased :</i>		
Cost involved is purchase price plus fixed cost	Rs. 27	Rs. 50
<i>If manufactured :</i>		
Cost involved is total cost	Rs. 30	Rs. 45
<i>Decision taken</i>	<i>To purchase</i>	<i>To manufacture</i>

A misleading decision would be taken on the basis of total cost analysis as it would appear that in the case of product B the total cost being much higher than the purchase price, it should be bought instead of being manufactured. Such a decision would obviously result in loss.

In another situation where the production capacity released by a decision to buy can be utilized (situation 2) or in a situation where productive capacity has to be diverted for manufacturing a product which was so long being purchased (situation 3) comparison between purchase price and relevant costs would be made taking into account the opportunity cost involved. In the above example, if we assume that Product B can be manufactured only by diverting the production capacity of another Product C which at present gives a contribution of Rs. 10,000 the analysis will be as shown on the next page.

Costs of making	Rs. 90,000		
Opportunity cost (loss of contribution from Product C)	Rs. 10,000		
Relevant cost	Rs. 1,00,000		<i>Difference</i>
Cost of buying		Rs. 60,000	Rs. 40,000

The decision will, therefore, be to buy product B and utilize the production capacity for product C.

In a situation where it is proposed to acquire additional facilities for manufacture (situation 4), comparison should be made between the purchase price and the marginal cost plus the additional traceable fixed cost likely to be incurred for manufacturing, such as additional staff, interest on the cost of added plants, buildings, equipments etc. If the demand for the product is of a fluctuating nature, the management may not like to incur additional fixed cost which may become a permanent burden.

Several other considerations not directly related to costs apply in make or buy decision making. For example, the decision to buy will be taken (i) if an uninterrupted supply of requisite quality from reliable sources of supply is ensured and (ii) there is wide fluctuation in the demand for the end product which would make the internal set-up for manufacturing the components concerned uneconomic. On the other hand, if secrecy is to be maintained, the manufacturing know-how cannot be passed on to the suppliers and the decision will be to make only.

The make or buy decision is also seriously affected if the transaction involving the product is so large in relation to the transaction for the product in the market that any attempt to obtain supplies from outside will have the effect of driving the market price up and any attempt to produce internally will drive the price down.

It may be stated here that when facilities for manufacture do not exist and new plants, equipments etc. have to be installed, all costs and other factors and not only the marginal costs are to be considered for make or buy decisions.

(iii) *Assessment of capital investment plans* : This is an important problem requiring careful attention on the part of the management. The subject has been dealt with in detail in Chapter 16. A simple example is, however, given below which will show how marginal contribution analysis is able to assist the management in decision making.

EXAMPLE 9.4.

The present output details of a manufacturing department are as follows :

Average output per week	.. 48,000 units from 160 employees
Salable value of output	.. Rs. 6,00,000
Contribution made by output towards fixed expenses and profit	.. Rs. 2,40,000

The board of directors plans to introduce more mechanisation into the department at a capital cost of Rs. 1,60,000. The effect of this will be to reduce the number of employees to 120, but to increase the output per individual employee by 60%. To provide the necessary incentive to achieve the increased output, the board intends to offer a 1% increase on the piece work price of one rupee per article for every 2% increase in average individual output achieved. To sell the increased output, it will be necessary to decrease the selling price by 4%.

Calculate the extra weekly contribution resulting from the proposed change and evaluate, for the board's information, the worth of the project. (I.C.M.A., Final—Adapted)

ANSWER :

Marginal cost – Sales *minus* Contribution – Rs. 6,00,000 – Rs. 2,40,000 – Rs. 3,60,000

Marginal cost per unit (excluding wages) $\frac{\text{Rs. 3,60,000} - \text{Rs. 48,000}}{48,000}$ – Rs. 6.50

Present output per employee – $\frac{48,000}{160}$ – 300 units

Expected output (total) 120 \times (300 + 60% of 300) 57,600 units

Present piece work – Re. 1 per article

Proposed piece work – Re. 1 + 30% of Re. 1 Rs. 1.30

Present sale price per unit Rs. 12.50

Proposed sale price per unit – Rs. 12.50 less 4% of Rs. 12.50 – Rs. 12

The proposed project's analysis is as follows :

Sale (units)		57,600
Sale (value)		Rs. 6,91,200
Marginal cost (excluding wages)	Rs. 3,74,400	
Wages	Rs. 74,880	
Total marginal cost	Rs. 4,49,280	
Marginal contribution		Rs. 2,41,920
Less Present contribution		Rs. 2,40,000
Increase in contribution		Rs. 1,920 per week
Pay back period	$\frac{\text{Rs. 1,60,000}}{\text{Rs. 1,920}}$	84 weeks

The project is recommended, assuming that the increase in fixed overhead, if any, is less than the increase in contribution.

(iv) *Optimising product mix* : Product mix refers to the volume relationship between the various products manufactured by a company. For example, if a company manufacturing 200 units of product A and 300 units of product B in a month desires to plan for a monthly production of 250 units of product A and 250 units of product B in future, we would say that a change in the product mix is contemplated though there is no change in the total or overall volume which in both cases is 500 units. When a concern manufactures a number of products, a problem often arises as to which product mix or sale mix will give the maximum profit. In other words, what should be the best combination of varying quantities of the different products which could be selected from amongst the various alternative combinations available ? Such a problem can be solved with the help of marginal contribution cost analysis ; the product mix which gives the maximum possible margin will be the optimum mix. The approach is based on the assumption that fixed costs remain constant for alternative product mixes being considered and as such are not relevant to the decision. Traceable fixed costs which would change with the change in the volume of a product should, however be included by treating them as if they were variable costs. Let us consider following analysis made in respect of three products manufactured in a cor

	Product 1 (Rs.)	Product 2 (Rs.)	Product 3 (Rs.)
Per unit Sales price	25	30	18
Material	6	8	2
Labour	5	4	6
Variable overhead	4	3	5
Marginal cost	15	15	13
Marginal contribution	10	15	5

Out of the three products, Product 2 gives the highest contribution per unit. Therefore, if no other factors intervene, the production capacity will be utilized to the maximum possible extent for the manufacture of that product. Product 1 ranks next and so, after meeting the requirement of Product 2, the capacity will be utilized for Product 1. Whatever capacity is available thereafter may be utilized for product 3.

The method of optimising product mix is further explained below. (At this stage, reference should be made to the problem of the limiting factor (Page 492) before proceeding further with these illustrations.

EXAMPLE 9.5.

Given the following information, you are required to :

- Calculate and present the marginal product cost and contribution per unit.
- State which of the alternative sales mixes you would recommend to the management, and why.

	Per unit
Selling price	X Rs. 25
Selling price	Y Rs. 20
Direct materials	X Rs. 8
Direct materials	Y Rs. 6
Direct wages	X 24 hrs. at Re. 0.25 per hour
Direct wages	Y 16 hrs. at Re. 0.25 per hour
Fixed overhead	Rs. 750
Variable overhead	150% of direct wages

Alternative sales mix :

- 250 units of X and 250 units of Y
- Nil units of X and 400 units of Y
- 400 units of X and 100 units of Y

(I.C.M.A., Inter—Adapted)

ANSWER :

Contribution Analysis

	Product X Rs. 25	Product Y Rs. 20
Sales		
Marginal cost :		
Direct material	Rs. 8	Rs. 6
Direct wages	Rs. 6	Rs. 4
Variable overhead	Rs. 9	Rs. 6
	Rs. 23	Rs. 16
Contribution per unit	Rs. 2	Rs. 4
Contribution per hour	Re. 0.83	Re. 0.25
P/V ratio	8%	20%

Alternative (i)

Total contribution ($250 \times \text{Rs. } 2 + 250 \times \text{Rs. } 4$)	Rs. 1,500
Fixed overhead	Rs. 750
Net profit	Rs. 750

Alternative (ii)

Total contribution ($400 \times \text{Rs. } 4$)	Rs. 1,600
Fixed overhead	Rs. 750
Net profit	Rs. 850

Alternative (iii)

Total contribution ($400 \times \text{Rs. } 2 + 100 \times \text{Rs. } 4$)	Rs. 1,200
Fixed overhead	Rs. 750
Net profit	Rs. 450

Alternative No. (ii) which yields the highest contribution is recommended

As product Y gives twice as much contribution per unit as product X, provision of facilities for producing more units of Y should be considered, even by increasing, if necessary, sales promotion expenses.

EXAMPLE 9.6.

A manufacturer with an overall (interchangeable among the products) capacity of one lakh machine hours has been so far producing a standard mix of 15,000 units of Product A ; 10,000 units of Products B and C each. On experience the total expenditure exclusive of his fixed charges is found to be Rs. 2.09 lakhs and the cost ratio among the products approximates 1.15 : 1.75 respectively per unit. The fixed charges come to Rs. 2.00 per unit. When the unit selling prices are Rs. 6.25 for A, Rs. 7.50 for B and Rs. 10.50 for C, he incurs a loss.

He desires to change the product mix as under —

	Mix 1	Mix 2	Mix 3
A	18,000	15,000	22,000
B	12,000	6,000	8,000
C	7,000	13,000	8,000

As a Cost Accountant what mix will you recommend?

(I.C.W.A., Final)

ANSWER :

	Product A Per unit	Product B Per unit	Product C Per unit
Sale	Rs. 6.25	Rs. 7.50	Rs. 10.50
Variable cost	Rs. 4.40	Rs. 6.60	Rs. 7.70
Contribution per unit	Rs. 1.85	Rs. 0.90	Rs. 2.80

The total variable cost of Rs. 2.09 lakhs is distributed as follows :

Equivalent of Product A : Product A 15,000 units
 Product B 15,000 units ($10,000 \times 1.50$)
 Product C = 17,500 units ($10,000 \times 1.75$)

47,500 units

Variable cost per unit : Product A = $\frac{\text{Rs. } 2,09,000}{47,500} = \text{Rs. } 4.40$

Product B = $\text{Rs. } 4.40 \times 1.50 = \text{Rs. } 6.60$

Product C = $\text{Rs. } 4.40 \times 1.75 = \text{Rs. } 7.70$

Comparative contribution analysis

	Mix 1	Mix 2	Mix 3
Contribution*	Rs. 63,700	Rs. 69,550	Rs. 70,300
Fixed cost	Rs. 70,000	Rs. 70,000	Rs. 70,000
Net profit	(—)Rs. 6,300	(—)Rs. 450	Rs. 300
*(Mix 1. $18,000 \times \text{Rs. } 1.85 + 12,000 \times \text{Rs. } 0.90 + 7,000 \times \text{Rs. } 2.80 = \text{Rs. } 63,700$			
Mix 2. $15,000 \times \text{Rs. } 1.85 + 6,000 \times \text{Rs. } 0.90 + 13,000 \times \text{Rs. } 2.80 = \text{Rs. } 69,550$			
Mix 3. $22,000 \times \text{Rs. } 1.85 + 8,000 \times \text{Rs. } 0.90 + 8,000 \times \text{Rs. } 2.80 = \text{Rs. } 70,300$			

It is assumed that the fixed cost of Rs. 70,000 (35,000 units of present mix @ Rs. 2) remains constant for all the proposed mixes.

Mix No. 3 which gives the maximum contribution and a net profit of Rs. 300 after recovering fixed costs is recommended.

EXAMPLE 9.7.

A market gardener is planning his production for next season and he asked you, as a cost accountant, to recommend the optimal mix of vegetable production for the coming year. He has given you the following data relating to the current year :

	Potatoes	Turnips	Parsnips	Carrots
Area occupied, in acres	25	20	30	25
Yield per acre, in tonnes	10	8	9	12
	£	£	£	£
Selling price per tonne	100	125	150	135
Variable costs per acre :				
fertilisers	30	25	45	40
seeds	15	20	30	25
pesticides	25	15	20	25
direct wages	400	450	500	570
Fixed overhead per annum :	£54,000			

The land which is being used for the production of carrots and parsnips can be used for either crop, but not for potatoes or turnips. The land being used for potatoes and turnips can be used for either crop, but not for carrots or parsnips. In order to provide an adequate market service, the gardener must produce each year at least 40 tonnes each of potatoes and turnips and 36 tonnes each of parsnips and carrots.

- (a) You are required to present a statement to show :
 - (i) the profit for the current year ;
 - (ii) the profit for the production mix which you would recommend.
- (b) Assuming that the land could be cultivated in such a way that any of the above crops could be produced and there was no market commitment, you are required to :
 - (i) advise the market gardener on which crop he should concentrate his production ;
 - (ii) calculate the profit if he were to do so ; and
 - (iii) calculate in sterling the break-even point of sales. (I.C.M.A., Pt. I)

ANSWER :

- (a) The costs and revenue are as under :

	Potatoes	Turnips	Parsnips	Carrots
Variable cost per acre	£470	£510	£595	£660
Tonnes per acre	10	8	9	12
Revenue per tonne	£100	£125	£150	£135
Revenue per acre	£1,000	£1,000	£1,350	£1,620

(i) *Position in the current year :*

	Potatoes	Turnips	Parsnips	Carrots	Total
Acres	25	20	30	25	100
	£	£	£	£	£
Revenue	25,000	20,000	40,500	40,500	126,000
Variable cost	11,750	10,200	17,850	16,500	56,300
Contribution	13,250	9,800	22,650	24,000	69,700
Fixed overhead					54,000
Profit					£15,700

The crops arranged in order of higher contribution would be .

Carrots, Parsnips, Potatoes, and Turnips

Groupwise, the contribution ratings would be :

Area I . Potatoes, Turnips

Area II . Carrots, Parsnips

(ii) *Profit from the recommended Crop mix :*

	Area I (45 acres)		Area II (55 acres)		
	Potatoes	Turnips	Parsnips	Carrots	
Contribution per acre	£530	£490	£755	£960	
Minimum tonnes	40	40	36	36	
Acres required	4	5	4	3	
Balance allocated to better crop	36	—	—	48	
Recommended mix, acres	40	5	4	51	
					Total
Contribution	£21,200	£2,450	£3,020	£48,960	£75,630
Fixed overhead					£54,000
Profit					£21,630

(b) (i) Production should be concentrated on carrots which yield the highest contribution per acre.

(ii) Contribution from carrots (45 + 55 = 100 acres)	£96,000
Fixed overhead	£54,000
Profit	£42,000

(iii) Break-even point $\frac{\text{Fixed overhead}}{\text{Contribution/Sales}}$ (See Page 514)

$$\frac{£54,000}{£24,000/£40,500} = £91,125$$

(v) *Alternative use of production facilities :* When alternative use of production facilities or alternative methods of manufacturing a product are available, marginal contribution analysis should be made to arrive at the final choice. The alternative which will yield the highest contribution will obviously be selected unless :

- (i) it is possible to improve by some means such as by raising prices, the margin on the alternative proposed to be discarded, or
- (ii) the demands for the several products are inter-related so that the elimination or reduction in the quantity of the product having lower margin results in drop of demand of the more profitable product, or
- (iii) it is possible to revive only after large investment, the sale of the product once withdrawn even if its contribution improves at any future date, or
- (iv) increased sales of the high margin product is possible only by incurring heavy additional promotional expenditure.

Let us consider the following illustration, where the choice between two machines for the processing of a product is required to be made :

Machine	A	B
Production per hour	10	15
Per unit :	(Rs.)	(Rs.)
Selling price	120	120
Material	45	45
Labour	20	15
Variable overhau	30	45
Marginal cost	95	105
Contribution	25	15
Contribution per hour	250	225

Machine A, though slower in speed, gives a higher contribution both per unit and per hour. The choice, therefore, is for this machine, provided no other restraints apply.

Problem of the Limiting Factor. Under the marginal cost concept, profitability is measured with reference to the aggregate of the marginal contribution yield from all the products sold. The main objective of a concern is to maximize profit and for this purpose, it would employ all its resources to manufacture and sell the maximum quantities of products which yield the highest individual marginal contribution. In the examples given in the foregoing paragraphs, it was assumed that, in general, it was possible for an undertaking to increase the manufacture, at will, of the product which yielded the highest marginal contribution and that there was no limitation which could curb this action. In practice, however, varying situations arise which put a limit on the efforts of the management to produce as many units of a selected product as they would like to. An undertaking, for instance, may have all the resources at its command except that it is unable to obtain the full quantity of materials needed for manufacture. Thus, material constitutes a limiting factor in this case. Let us consider another example :

	Product A Per unit	Product B Per unit
Sales	Rs. 25	Rs. 20
Variable cost	Rs. 13	Rs. 12
Contribution	Rs. 12	Rs. 8
Contribution ratio	48%	40%

On the basis of the contributions per unit of the products, product A which yields higher contribution per unit should be more profitable than product B. If however, it is assumed that the machine capacity is limited to 500 hours and 3 and 5 units respectively of products A and B are produced in one hour, the contribution per machine hour will be as follows :

	Product A	Product B
Contribution per hour	Rs. 12×3 - Rs. 36	Rs. 8×5 Rs. 40
Total contribution for 500 hours	Rs. 18,000	Rs. 20,000

Obviously, the decision will be in the favour of increasing the production and sale of product B which makes more profitable use of the limiting factor.

A *limiting factor* (also termed *scarce factor*) is defined as the factor in the activities of an undertaking which, at a particular point of time or over a period, will limit the volume of output. Limiting factors are governed by both internal and external factors and arise due to the shortage of one or more of the factors of production and sales such as capital, labour of the required grades, trade and skill, efficient staff and executives, plant and machinery, raw materials, consumer demand, and sales personnel. We have seen that when a limiting factor is operating, the contribution of each item of a product mix per unit of the limiting factor should be taken into consideration for determining the highest contribution which may possibly be obtained. This is further illustrated in the examples given below.

EXAMPLE 9.8.

The following particulars are extracted from the records of a company :—

	Per unit	
	Product A	Product B
Sales	Rs. 100	Rs. 120
Consumption of material	2 kgs.	3 kgs.
Material cost	Rs. 10	Rs. 15
Direct wages cost	Rs. 15	Rs. 10
Direct expenses	Rs. 5	Rs. 6
Machine hours used	3	2
Overhead expenses :		
Fixed	Rs. 5	Rs. 10
Variable	Rs. 15	Rs. 20

Direct wages per hour is Rs. 5. Comment on the profitability of each product (both use the same raw material) when :

- Total sales potential in units is limited ;
- Total sales potential in value is limited ;
- Raw material is in short supply ;
- Production capacity (in terms of machine hours) is the limiting factor.

Assuming Raw Material as the key factor, availability of which is 10,000 kgs. and maximum sales potential of each product being 3,500 units, find the product mix which will yield the maximum profit.
(I.C.W.A., Inter)

ANSWER :

<i>Per unit</i>	<i>Product A</i>	<i>Product B</i>
	Rs.	Rs.
Sales	100	120
Material	10	15
Direct wages	15	10
Direct expenses	5	6
Variable overhead	15	20
Total variable cost	45	51
Marginal contribution per unit	55	69
Marginal contribution per kg. of material	27.50	23
Marginal contribution per machine hour	18.33	34.50

When the limiting factor is :

Sales	:	Ranking is	BA
Raw Material	:	" "	AB
Production Capacity	:	" "	BA

When raw material is scarce and limited to 10,000 kgs. and maximum production limit is 3,500 units of each, the raw material allotment will be :

Product A—7,000 kgs. for 3,500 units

Product B—3,000 kgs. for 1,000 units

Total contribution = $3,500 \times \text{Rs. } 55 + 1,000 \times \text{Rs. } 69 = \text{Rs. } 1,92,500 + \text{Rs. } 69,000 = \text{Rs. } 2,61,500$

Total fixed cost = $3,500 \times \text{Rs. } 5 + 1,000 \times \text{Rs. } 10 = \text{Rs. } 17,500 + \text{Rs. } 10,000 = \text{Rs. } 27,500$

Total profit = $(\text{Rs. } 1,92,500 - \text{Rs. } 17,500) + (\text{Rs. } 69,000 - \text{Rs. } 10,000) = \text{Rs. } 2,34,000$

EXAMPLE 9.9.

The board of directors of KF Limited, manufacturers of three products A, B & C, have asked for advice on the production mixture of the company.

(a) You are required to prepare a statement to advise the directors of the most profitable mixture of the products to be made and sold. The statement should show :

(i) the profit expected on the current budgeted production, and

(ii) the profit which could be expected if the most profitable mixture was produced.

(b) You are also required to direct the directors' attention to any problems which are likely to arise if the mixture in (a) (ii) above were to be produced.

The following information is given :

Data for Standard Costs, per unit

		Product A	Product B	Product C
		Rs.	Rs.	Rs.
Direct materials	..	10	30	20
Variable overhead	..	3	2	5
Direct labour :				
Department	Rate per hour	Hours	Hours	Hours
	Rs.			
1	0.5	28	16	30
2	1.0	5	6	10
3	0.5	16	8	30
Data from current budget production				
in thousands of units per year		10	5	6
Selling price per unit		Rs. 50	Rs. 68	Rs. 90
Forecast by sales director of maximum possible sales for the year 1973 :				
in thousands of units		12	7	9

Fixed overhead per year : Rs. 2,00,000

However, the type of labour required by department 2 is in short supply and it is not possible to increase the manpower of this department beyond its present level.

(I C M A., Pt II—Adapted)

ANSWER .

Profit Statement (Budgeted production)

	Product A	Product B	Product C	Total
Units	10,000	5,000	6,000	21,000
	Rs.	Rs.	Rs.	Rs.
Sales	5,00,000	3,40,000	5,40,000	13,80,000
Direct materials	1,00,000	1,50,000	1,20,000	3,70,000
Direct wages Dept 1	1,40,000	40,000	90,000	2,70,000
2	50,000	30,000	60,000	1,40,000
3	80,000	20,000	90,000	1,90,000
Variable overheads	30,000	10,000	30,000	70,000
Marginal costs	4,00,000	2,50,000	3,00,000	10,40,000
Marginal contribution	1,00,000	90,000	1,50,000	3,40,000
Fixed overheads				2,00,000
Net Profit				Rs. 1,40,000
Marginal cost per unit	Rs. 40	Rs. 50	Rs. 65	
Marginal contribution per unit	Rs. 10	Rs. 18	Rs. 25	
Marginal contribution percentage to key factor (i.e. wages of Dept 2)	200%	300%	250%	Ranking BCA

As the key factor is to be utilised fully, production hours should first be concentrated on products B and C and the balance (out of maximum, $10,000 \times 5 + 5,000 \times 6 + 6,000 \times 10$, i.e., 1,40,000 hours) should be used by Product A. The position will be

Production	Units	Dept 2	Total hours
		Hours per product unit	
B	7,000	6	42,000
C	9,000	10	90,000
A	1,600	5	8,000
			1,40,000

Profit Statement (Most profitable mix)

	Product A	Product B	Product C	Total
Units	1,600	7,000	9,000	17,600
	Rs.	Rs.	Rs.	Rs.
Sales	80,000	4,76,000	8,10,000	13,66,000
Marginal costs	64,000	3,50,000	5,85,000	9,99,000
Marginal contribution	16,000	1,26,000	2,25,000	3,67,000
Fixed overheads				2,00,000
Net profit				Rs. 1,67,000

Before a final decision is taken, it should be seen whether :

- (a) The demand for product A is complementary to the demand for the other products ; (if so, sales of products B and C are likely to fall).
- (b) There will not be any damage to customer goodwill due to shortfall in the sales of product A.

While analysing the impact of limiting factors on profitability and marginal contribution, it is essential that these factors be correctly ascertained ; otherwise, decisions taken on wrong assumptions regarding a limiting factor will obviously be erroneous. When there is a severe limitation of a factor of production like acute material or labour shortage, it is easy to pick out the constraining factor and determine the relationship of the marginal contribution with such a factor. In practice, however, pinpointing the constraints is a complicated problem, particularly where a number of different materials are used in the manufacture of a variety of products which run on various types of machines or pass through various processes. In such cases, a careful and detailed examination of the business conditions is necessary in order to ascertain the actual and anticipated limitations. The nature of bottlenecks created in production and the reasons for which they arise should be examined so that each limiting factor may be linked with specific products or processes.

Situations where multiple limiting factors interplay need a more complex analysis. The solutions to such problems may be found with the help of the technique of *Linear Programming*, discussed in Chapter 19.

When internal or external economic conditions are liable to change quickly, the limiting factors also undergo rapid changes. A particular limiting factor arising at a specified period or point of time may disappear and give place to another shortly thereafter, in which case the usefulness of the analysis of the marginal contribution vis-a-vis the limiting factor becomes limited. Care should be taken to anticipate the limiting factor likely to occur at the time when production will actually take place. In other words, the anticipated and not the actual factor current at the time should be taken into consideration for decision making.

Limitations of Marginal Costing. The marginal costing technique has certain limitations that should be kept in view while utilizing marginal cost data to deal with specific problems arising in specific situations. These *limitations* are summarised below :

- (i) The separation of costs into fixed and variable presents technical difficulties and no variable cost is completely variable nor is a fixed cost completely fixed. The variable cost sometimes deviates from its usual manner of variation in a linear pattern and varies in a curvilinear fashion. Changes in the volume of activity may thus be accompanied with changes in the variable cost per unit. Further, variable costs are resistant to any decrease consequent upon a sudden reduction in output. Then again, there are quite a large number of items which vary more with other bases, such as weight, order size, number of transactions, etc., rather than with sales. In view of these factors, the basic data on which marginal cost analysis is built up are not always reliable.

- (ii) Under the marginal cost system, stock of finished goods and work-in-progress are understated. After all, fixed costs are incurred in order to manufacture products and as such, these should form a part of the cost of the products. It is, therefore, not correct to eliminate fixed costs from finished stock and work-in-progress.
- (iii) The exclusion of fixed overhead from the inventories affects the Profit and Loss account and produces an unrealistic and conservative Balance Sheet, unless adjustments are made in the financial accounts at the end of the period.
- (iv) In marginal costing system, marginal contribution and profits increase or decrease with changes in sales volume. Where sales are seasonal, profits fluctuate from period to period. Monthly operating statements under the marginal costing system will not, therefore, be as realistic or useful as in absorption costing.
- (v) During the earlier stages of a period of recession, the low profits or increase in losses, as revealed in a magnified way in the marginal cost statements, may unduly create panic and compel the management to take action that may lead to further depression of the market.
- (vi) Marginal costing does not give full information. For example, increased production and sales may be due to extensive use of existing equipments (by working overtime or in shifts), or by an expansion of the resources, or by the replacement of labour force by machines. The marginal contribution fails to reveal these.
- (vii) Though for short-term assessment of profitability marginal costs may be useful, long term profit is correctly determined on full costs basis only.
- (viii) Although marginal costing eliminates the difficulties involved in the apportionment and under- and over-absorption of fixed overhead, the problem still remains so far as the variable overhead is concerned.
- (ix) With increased automation and technological developments, the impact of fixed costs on products is much more than that of variable costs. A system which ignores fixed costs is, therefore less effective because a major portion of the cost is not taken care of. There are certain machine fixed costs, such as depreciation and specific supervision, which are in the nature of traceable costs and should more appropriately be set against the marginal contributions of specific products passing through the machine.
- (x) Marginal costing does not provide any standard for the evaluation of performance. A system of budgetary control and standard costing provides more effective control than that obtained by marginal costing. The distortion of costs which marginal costing claims to obviate by excluding the fixed costs is taken care of in standard costing in the form of volume variance, which shows the effectiveness of the use of the resources and facilities of the undertaking. Marginal contribution data do not reveal many facts which are furnished by variance analysis. For example, efficiency variance reflects the efficient or non-efficient use of plant, machinery, and labour, which cannot be revealed through marginal cost analysis.

- (xi) The limitations of marginal cost analysis in regard to pricing policies were referred to previously. It may be added that undue emphasis on marginal costs for price decisions may tend to use up the existing resources by taking on heavy business with low margin resulting in heavy fixed costs in the shape of expansion of the resources, when need arises later for taking up more profitable lines. Dropping out the product line with low margin and utilizing the facilities so released for profitable production would perhaps have been more economical than expanding the facilities. Besides, fixed costs are also necessary for price fixation in certain circumstances. For instance, in cost-plus contracts, marginal costs cannot be used unless a high percentage over the marginal cost is taken into account to cover the fixed costs and profit.

Differential Cost (or Incremental Cost) Analysis. Differential cost is the change in the costs which results from the adoption of an alternative course of action. The alternative actions may arise due to change in sales volume, price, product mix (by increasing, reducing or stopping the production of certain items), or methods of production, sales, or sales promotion, or they may be due to 'make or buy' or 'take or refuse' decisions. When the change in costs occurs due to change in the activity from one level to another, differential cost is referred to as *incremental cost* (or *decremental cost*, if a decrease in output is being considered), i.e. total increase in cost divided by the total increase in output. However, accountants generally do not distinguish between differential cost and incremental cost and the two terms are used to mean one and the same thing.

The computation of differential cost provides a useful method of analysis for the management for anticipating the results of any contemplated changes in the level or nature of activity. When policy decisions have to be taken, differential costs worked out on the basis of alternative proposals are compared with the expected changes in revenue associated with each proposal. Such an analysis which takes into account both costs and revenue would more appropriately be termed *incremental analysis*.

According to some accountants, the term, *avoidable costs* should be used synonymously with incremental costs, the former being defined as the costs that may be avoided or saved if a given alternative is not adopted. In the broader sense, however, avoidable costs mean those costs which can be identified with an activity or sector of a business and which would be avoided if that activity or sector did not exist.

The opposite term is *unavoidable cost* which represents the past cost or the *sunk cost* that would not be changed with any action taken. Unavoidable costs or sunk costs are not relevant to the particular decision making problem involved.

While considering the replacement of a plant, the depreciated book value of the old asset is irrelevant as the amount is a sunk cost which is to be written off at the time of replacement. Unlike incremental or decremental costs, sunk costs are not affected by increase or decrease in volume.

The determination of differential cost is simple. Differential cost represents the algebraic difference between the relevant costs for the alternatives being

considered. Thus, when two levels of activities are being considered, the differential cost is obtained by subtracting the cost at one level from the cost at another as shown below :

	Alternative 1	Alternative 2	Differential costs and revenue
	Rs.	Rs.	Rs.
Sales	10,000	12,000	2,000
Direct labour	2,000	2,200	200
Direct material	1,500	1,800	300
Variable and semi-variable overhead	1,500	1,600	100
Fixed cost	2,000	2,000	—
Cost of sales	7,000	7,600	600
Profit	Rs. 3,000	Rs. 4,400	Rs. 1,400

Incremental revenue = Rs. 2,000

Differential cost = Rs. 600

In the above analysis, the fixed cost and a portion of the variable cost remain unaltered whichever alternative is chosen. Such cost is, therefore, not relevant in decision making and it is not affected by the decision taken. If, however, additional fixed cost is incurred for increased volume, this will be considered.

The task of differential cost analysis becomes simple if a flexible budget showing the costs at various levels of production is prepared. The method of preparation of flexible budget and its link up with differential costs have been discussed in another chapter.

The determination of differential costs is also possible with the help of linear equations. At two levels of production, the equations of costs may be represented as :

$$y_1 = mx_1 + F$$

$$y_2 = mx_2 + F$$

where y_1, y_2 = Cost

x_1, x_2 = Levels of production

F = Fixed cost

m = Marginal or variable cost per unit of production

$$\begin{aligned} \text{Differential cost} &= y_2 - y_1 = (mx_2 + F) - (mx_1 + F) \\ &= m(x_2 - x_1) \end{aligned}$$

If the variable cost at normal capacity (say 80%) be assumed to be Rs. 20,000, the differential cost between 75% and 80% activities (i.e. for a difference of 5%) will be :

$$\text{Differential cost} = \frac{\text{Rs. } 20,000}{80} \times 5 = \text{Rs. } 1,250$$

Thus at 75% activity, variable cost will be equal to (Rs. 20,000 – Rs. 1,250) = Rs. 18,750

The essential features of differential costs are as follows :—

- (i) The basic data used for differential cost analysis are costs, revenue, and the investment factors relevant in the problem for which the analysis is undertaken.
- (ii) Total differential costs rather than the costs per unit are considered.

- (iii) Differential cost analysis is made outside the accounting records. Differential costs do not form a part of the accounting system but have to be specially analysed with the help of the routine accounting records. Differential costs may, however, be incorporated in the budgets.
- (iv) As the difference in the costs at two levels are considered, absolute costs at each level are not as relevant as the difference between the two. Thus, items of costs which do not change but are identical for the alternatives under consideration, are ignored.
- (v) The differentials are measured from a common base point or position, e.g. the present level of activity may be a good starting point for the calculation of the differentials.
- (vi) The stage at which the difference between the revenue and the cost is the highest, measured from the common base point, determines the choice from amongst a number of alternative actions, assuming that no additional fixed assets or working capital are required.
- (vii) In computing differential costs, historical or standard costs may be used but they should be adjusted to the requirements of future conditions. When alternative actions are being considered, they always relate to the future course of action and as such, differential cost should deal with future costs only.
- (viii) The elements and items of cost to be considered in differential cost analysis will depend upon the nature of the problem and the alternatives being considered. For example, if discontinuance of manufacture of a product is under consideration, the variable costs as well as a part of the fixed costs which it may be possible to avoid, i.e. the direct fixed or traceable cost, will be taken into account.

Differential Cost Analysis and Marginal Costing. Although the techniques of differential costs analysis are similar to those of marginal costing, the two should not be confused. The points of similarity and difference between differential costs analysis and marginal costing are summarised below :

Similarity

- (1) Both are techniques of cost analysis and cost presentation.
- (2) Both are made use of by the management in decision making and in formulating policies.
- (3) The concepts of differential costs and marginal costs mainly arise out of the difference in the behaviour of fixed and variable costs.
- (4) Differential costs compare favourably with the economist's definition of marginal cost, viz. that marginal cost is the amount which at any given volume of output is changed if output is increased or decreased by one unit.

Difference

- (1) Differential cost analysis can be made in the case of both absorption costing as well as marginal costing. In either case only relevant costs, i.e. the future costs which change with the alternative courses of action are considered;

- (2) While marginal costing excludes the entire fixed costs, some of the fixed costs may be taken into account as being relevant for the purpose of differential cost analysis.
- (3) Marginal costs may be embodied in the accounting system whereas differential costs are worked out separately as analysis statements.
- (4) In marginal costing, margin of contribution and contribution ratio are the main yardsticks for performance evaluation and for decision making. In differential cost analysis, differential costs are compared with the incremental or decremental revenues, as the case may be.

Practical Applications of Differential Costs. Problems dealt with by differential costs analysis may be categorised into two types, viz. those which involve capital outlay investment and those which do not. Capital investment problems have been discussed in Chapter 16. Some of the problems under the second category are dealt with here.

(1) *Determination of the most profitable levels of production and price* : In the determination of prices and the optimum level of production which would give maximum profits, the selling prices which are expected to absorb output at various levels of activity are assessed, say, by means of market research. The estimated revenue at each level is obtained by multiplying the expected output at that level with the estimated price, and the incremental or differential revenues at the various levels are determined by subtracting the sales value at one level from the sales value at the adjacent level. The differential costs are then matched with the incremental revenue to determine the best price and the optimum volume of production.

The method is illustrated in the example given below :

EXAMPLE 9 10

Modern Sewing Machines Co manufactures hand operated sewing machines in batches of 60,000. Prepare a schedule showing the total differential costs and increments in revenue from the following data. At what volume the company should set its level of production?

Output (No. in lakhs)	Selling price per machine	Total semi- fixed cost (Rs. in lakhs)	Total variable cost (Rs. in lakhs)	Total fixed cost (Rs. in lakhs)
0.60	240	30	83.6	28.4
1.20	220	30	153.6	28.4
1.80	200	34	255.6	28.4
2.40	180	34	315.6	28.4
3.00	160	40	355.6	28.4
3.60	140	40	380.4	28.4

(I.C.W.A., Final)

ANSWER :

Output (No. in lakhs)	Revenue (Rs. in lakhs)	Incremental Revenue (Rs. in lakhs)	Total costs (Rs. in lakhs)	Differential cost (Rs. in lakhs)
0.60	144	—	142	—
1.20	264	120	222	80
1.80	360	96	318	96
2.40	432	72	378	60
3.00	480	48	424	46
3.60	504	24	448.8	24.8

As long as the incremental revenue exceeds the differential costs, it is profitable to increase output. It would be of no advantage to increase production as soon as differential cost equals or exceeds the incremental revenue. In the above example, the incremental revenue is higher than differential costs up to the output level of 3,00,000. The level of production should, therefore, be set at 3,00,000 and the sale price at Rs. 160.

(ii) *Acceptance of special orders—offer at a lower price or offering a quotation at lower selling price in order to increase capacity* : The problem involved is whether production capacity should be increased when the increased production can be sold only at a reduced sale price. The method of analysis is illustrated below :

EXAMPLE 9.11.

A company is at present working at 90 per cent of its capacity and producing 13,500 units per annum. It operates a flexible budgetary control system. The following figures are obtained from its budget :

	90%	100%
	Rs.	Rs.
Sales	15,00,000	16,00,000
Fixed expenses	3,00,500	3,00,600
Semi-fixed expenses	97,500	1,00,500
Variable expenses	1,45,000	1,49,500
Units made	13,500	15,000

Labour and material costs per unit are constant under present conditions. Profit margin is 10 per cent.

- You are required to determine the differential cost of producing 1,500 units by increasing capacity to 100 per cent.
- What would you recommend for an export price for these 1,500 units taking into account that overseas prices are much lower than indigenous prices?

(I.C.W.A., Final)

ANSWER :

Sales at 90% capacity	Rs. 15,00,000
Less Profit 10%	1,50,000
Cost of goods sold	13,50,000
Less Expenses (fixed, semi-variable, and variable)	5,43,000
Cost of labour and material	Rs. 8,07,000

$$\begin{aligned} \text{Labour and material at 100\% capacity} &= \text{Rs. } 8,07,000 \times \frac{100}{90} \\ &= \text{Rs. } 8,96,667 \end{aligned}$$

Differential cost analysis will be as follows :

	90% Capacity	100% Capacity	Differential cost
	Rs.	Rs.	
Production units	13,500	15,000	
Material and labour	8,07,000	8,96,667	
Variable expenses	1,45,000	1,49,500	
Semi-variable expenses	97,500	1,00,500	
Fixed expenses	3,00,500	3,00,600	
Total costs	Rs. 13,50,000	Rs. 14,47,267	Rs. 97,267

(a) Differential cost = Rs. 97,267

(b) Minimum price for export = $\frac{\text{Rs. } 97,267}{1,500} = \text{Rs. } 64.84$ per unit

At this price there is no addition to revenue ; any price above Rs. 64.84 per unit may be acceptable.

It is assumed that no capital investment is necessary and no export charges are incurred and that the export price will have no effect on the home market where the product will continue to be sold at the old price. It is also assumed that necessary precautions have been taken to ensure that the product is not 'dumped' back. (See Example 9.3)

(iii) *Depth or degree of processing* : Differential cost analysis may be applied to decide whether it would be more profitable to sell a product as it is or to process it further into a different product to be sold at an increased price ; the decision will be arrived at by comparing the added cost of manufacture with the incremental revenue. The cost incurred up to the split-off point is not taken into account, being not relevant to the issue. This is illustrated below :

EXAMPLE 9.12.

A company manufactures two joint products, A and B. The data for a month are :

	Production Kgs.	Sale price per kg.
A	1,000	Rs. 20
B	2,000	Rs. 30

By further processing it is possible to convert product B into another product C which can be sold at Rs. 70 per kg. The additional cost involved in processing 2,000 kgs. of B is Rs. 8,000 and the output is 1,000 kgs. of C.

Would you advise the management to go in for further processing the product B?

ANSWER :

Incremental revenue :

Product C, 1,000 × Rs. 70 = Rs. 70,000

Less Product B, 2,000 × Rs. 30 = Rs. 60,000

Rs. 10,000

Incremental cost :

Additional processing cost Rs. 8,000

Incremental profit Rs. 2,000

Further processing is recommended.

EXAMPLE 9.13.

FPI Limited is in the food processing industry and in one of its processes, three joint products are manufactured. Traditionally, the company has apportioned cost incurred up to the joint products pre-separation point on the basis of weight of output of the product.

You have been recently appointed cost accountant, and have been investigating process costs and accounting procedures.

You are required to prepare statements for management to show :

- the profit or loss of each product as ascertained using the weight basis of apportioning pre-separation point costs ;
- the optimal contribution which could be obtained from the manufacture of these products.

The following process data for October are given :

Costs incurred up to separation point Rs. 96,000

	Product A Rs.	Product B Rs.	Product C Rs.
Costs incurred after separation point	20,000	12,000	8,000
Selling price per tonne :			
Completed product	500	800	600
Estimated, if sold at separation point	250	700	450
	tonnes	tonnes	tonnes
Output	100	60	80

The cost of any unused capacity after the separation point should be ignored.

(I.C.M.A., Pt. I—Adapted)

ANSWER :

(a)	Total Rs.	Product A Rs.	Product B Rs.	Product C Rs.	
Cost up to point of separation	96,000	40,000	24,000	32,000	Appportioned on the basis of weight of output
Cost after separation point	40,000	20,000	12,000	8,000	
Total costs	1,36,000	60,000	36,000	40,000	
Sales revenue	1,46,000	50,000	48,000	48,000	
Profit/Loss	10,000	(—)10,000	12,000	8,000	

(b)	Product A	Product B	Product C
Output (tonnes)	100	60	80
	Rs.	Rs.	Rs.
Incremental revenue from further processing	25,000 (Rs. 500 - Rs. 250) × 100	6,000 (Rs. 800 - Rs. 700) × 60	12,000 (Rs. 600 - Rs. 450) × 80
Less Incremental cost	20,000	12,000	8,000
Incremental Profit/Loss	5,000	(-) 6,000	4,000

It will be seen from the above statement that there will be a loss of Rs. 6,000 if further processing of product B is done after the separation point. It is, therefore, recommended that product B should be sold at separation point. The optimal contribution based on this recommendation will be as follows :—

	Product A	Product B	Product C	Total
Output (tonnes)	100	60	80	
	Rs.	Rs.	Rs.	Rs.
Sales revenue	50,000 (Rs. 500 × 100)	42,000 (Rs. 700 × 60)	48,000 (Rs. 600 × 80)	1,40,000
Less Post-separation cost	20,000	—	8,000	28,000
Contribution	30,000	42,000	40,000	1,12,000
Less Cost upto point of separation				96,000

Profit

Rs. 16,000

(iv) *Determining the suitable price at which raw material may be purchased :*

The concept of differential costs analysis may be utilised for determining the suitable price to be paid for a raw material, if the concern is in a position to bargain with the supplier.

Let us assume that an offer has been received for the supply of 10,000 Kgs. of a raw material M. After processing (three processes are involved), the raw material would yield a product P, which is sold at Rs. 5 per Kg. The yield expected is 90% of P and 5% of a waste product with no market value, the rest being normal process loss. The differential costs of the processes (exclusive of the costs of material) are estimated as follows :

	Per Kg.
Process A	Re. 0.25
Process B	Re. 0.30
Process C	Re. 0.20
Total	Re. 0.75

With the above information, the following analysis will be obtained :

Revenue from product P (90% of 10,000 kgs. 9,000 kgs) @ Rs. 5 per kg.	Rs. 45,000
Differential cost of processing 10,000 kgs. of M @ Re. 0.75 per kg.	Rs. 7,500
Margin	<u>Rs. 37,500</u>
Margin per kg. of M $\frac{\text{Rs. } 37,500}{10,000}$	Rs. 3.75

The raw material may, therefore, be purchased at a price which should be less than Rs. 3.75 per kg., otherwise profit will be reduced.

Other problems that may be solved by differential costs analysis include the following :—

- (i) Adding a new product or business segment.
- (ii) Discontinuing a product or business segment in order to avoid or reduce the present loss or increase profit.
- (iii) Changing the product mix.
- (iv) Make or buy decisions.
- (v) Decision regarding alternative capital investment and plant replacement.
- (vi) Decision regarding change in method of production, e.g. machine labour to hand labour and vice-versa.

EXAMINATION QUESTIONS

1. What is Direct Costing system ? Discuss the application of 'Direct Cost' analysis in the formation of management policy (I.C.W.A., Final)
2. Direct cost is not full cost and distorts the valuation of finished stocks. Discuss the statement. (I.C.W.A., Final)
3. "Marginal costs reveal the lowest price at which a product can be sold during a trade depression, but they also reveal to management the most profitable lines during a period of intense trade activity."
Explain with examples, the second part of this statement. (I.C.M.A., Final)
4. There is general recession in the country which is considered to be of a temporary nature and the company, in which you are employed as a Cost Accountant, does not want to retrench personnel. An order is available for a product at a selling price which evidently is below the cost of production. What advice would you give to the management regarding this order, and why ? (I.C.W.A., Inter)
5. What are the various cost and non-cost considerations that have to be taken into account before a company can take a decision to make or buy certain parts or completed sub-assemblies for use in its manufacture. (I.C.W.A., Final)
6. In the concept of marginal costing, what is meant by "limiting factor"? State the difficulties experienced in the determination of the limiting factors in a concern and indicate how you would overcome them.
What are the limitations to the use of contribution per unit of the limiting factor as the indication of profitability ? (I.C.W.A., Final)
7. Several situations may arise where the method of marginal costing cannot be used without caution. Discuss the possible factors which may limit the use of marginal costing, pointing out the precautions to be borne in mind when making use of marginal costing technique. (I.C.W.A., Final)
8. Differential costs are basically 'special purpose' costs applicable only to a set of circumstances. Do you agree with this statement ? To what extent will it be prudent to take major policy decision regarding selling prices based on differential costs alone? Give reasons for your answer. (I.C.W.A., Final)

9. Chair Manufacturers Ltd. present the following information for the past year :

Material cost	Rs. 1,20,000
Labour cost	Rs. 2,40,000
Fixed overheads	Rs. 1,20,000
Variable overheads	Rs. 60,000
Units produced	12,000
Selling price	Rs. 50 per unit

The available capacity is a production of 20,000 units per year. The firm has an offer for the purchase of 5,000 chairs at a price Rs. 40 per unit. It is expected that by accepting this offer there will be saving of Re. 1 per unit in material costs on all units manufactured ; the fixed overheads will increase by Rs. 35,000 and the overall efficiency will drop by 2 per cent on all productions. Draft a report to the management giving your recommendations as to whether or not this offer should be accepted.

(I.C.W.A., Final)

10. The management of a company considers that product Y, one of its three main lines, is not as profitable as the other two with the result that no particular efforts are being made to push its sales. The selling prices and costs of the three products are :

Product	Selling price	Direct material	Direct Labour		
			Deptt. A	Deptt. B	Deptt. C
	Rs.	Rs.			
X	68	10	8	2	2
Y	58	6	2	8	2
Z	64	8	2	2	8

Overhead rates for each department per rupee of direct labour are as follows :

	Deptt. A	Deptt. B	Deptt. C
	Rs.	Rs.	Rs.
Variable overhead	1.20	0.40	1.00
Fixed overhead	1.20	2.00	1.40
Total	2.40	2.40	2.40

What advice would you give to the management about the profitability of product Y ?

Give reasons.

(I.C.W.A., Final)

11. A confectioner markets three products, all of which require sugar. His average monthly sales, cost of sales and sugar consumption are as follows :

	Product X	Product Y	Product Z	Total
Sales	Rs. 10,000	Rs. 12,000	Rs. 8,000	Rs. 30,000
Cost of sales	Rs. 6,000	Rs. 8,000	Rs. 5,600	Rs. 19,600
Sugar requirement	500 kg.	800 kg.	240 kg.	1,540 kg.

Due to Government restrictions his sugar quota has been reduced to 1,405 kg. per month. Suggest a suitable sales mix which would give the company maximum profit under the given circumstances.

(I.C.W.A., Final)

12. The overhead expenses of a factory, producing a single article, at different operating levels are as follows :—

Operating level capacity	Works overheads
	Rs.
80%	36,000
100%	40,000
120%	60,000
60%	33,000

The factory is currently working at 60 per cent operating level and its annual sales amount is Rs. 1,44,000.

Selling prices have been based on 100 per unit capacity and have the following relationship with costs at this level.

Factory cost	66.67% of sales value
Prime cost	75.00% of factory cost
Administrative and expenses (of which 75% is variable)	20.00% of sales value.

The management receives an offer for carrying out some work for another company valued at Rs. 33,000 per annum which will take up 40 per cent of capacity. The prime cost for the work is estimated at Rs. 20,000. There will be an addition to administrative expenses of Rs. 1,500 per annum.

The sales manager estimates that the sales of the company's own product will increase to 80 per cent of capacity by the time new order materializes.

Calculate the profits on current production. Give your views supported by figures, on the advisability of taking on the new work. (I.C.W.A., Final)

13. The figures below represent summarised results for three training periods :

	Period 1	Period 2	Period 3
Sales	£1,600,000	£2,400,000	£3,000,000
Material	£ 480,000	£ 720,000	£ 900,000
Wages and overhead	£ 880,000	£1,200,000	£1,500,000

The fixed overhead included in the figures above amounts to £320,000 in each period.

(a) For each of the three periods, present the information above in two tabulations, side by side to compare the calculated net profit to sales ratio in the first tabulation with the calculated marginal income ratio in the second.

(b) What conclusions can you draw from your tabulations? (I.C.M.A., Final)

14. A company has a capacity of producing 1,00,000 units of a certain product in a month. The Sales Department reports that the following schedule of sale prices is possible.

Volume of production	Selling price per unit
	Rs.
60%	0.90
70%	0.80
80%	0.75
90%	0.67
100%	0.61

The variable cost of manufacture between these levels is Re. 0.15 per unit and fixed cost Rs. 40,000.

- (a) Prepare a statement showing incremental revenue and differential cost at each stage. At which volume of production will the profit be maximum?
- (b) If there is a bulk offer at Re. 0.50 per unit for the balance capacity over the maximum profit volume for export and price quoted will not affect the internal sale, will you advice accepting this bid and why? (I.C.W.A., Inter)
15. (a) What is meant by 'Sales Mix'? What relation has this to cost-volume profit analysis?
- (b) Calculate the effect of change in 'Sales Mix' from the following data :

	Product				Total
	M	N	O	P	Rs.
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales in rupees	40,000	50,000	20,000	10,000	1,20,000
Variable cost in rupees	24,000	34,000	16,000	4,000	78,000
Fixed cost in rupees	..	..	..	..	29,400

The Sales Mix changed to :

	M	N	O	P	Rs.
M	30,000	
N	44,000	
O	40,000	
P	6,000	

Rs. 1,20,000

(I.C.W.A., Final)

16. Demand for the output of a certain company is very elastic and modern plant recently installed is capable of greatly increased production Output at present is 80,000 units

per year and half a million units annually are estimated to be within the capacity of the new plant.

The present selling price per unit is £15.

The need for flexible budgeting is recognised and six alternative levels of output in addition to the present level are contemplated six equal increments in annual output level, upto a maximum of 500,000 units, would involve corresponding reduction of £1 each in unit price to £9 per unit at the maximum output.

The present variable costs amount to £400,000. Fixed cost which at present amount to £200,000 are not expected to increase for any of the six alternative output levels contemplated. Semi-fixed costs are expected to vary from the present annual figures of £230,000 to £320,000, the upward steps being to £260,000 at 220,000 units, £280,000 at 360,000 units, and £320,000 at 500,000 units. The costs classified as variable at the six projected levels of output are calculated to be as follows :

£750,000 ; £100,000 ; £1,500,000 ; £1,750,000 ; £2,050,000 ; £2,500,000.

17. A company is at present working at 90% of its capacity and producing 13,500 units per annum. It operates a flexible Budgetary Control system. The following figures are obtained from its budget :

	90%	100%
	Rs.	Rs.
Sales	15,00,000	16,00,000
Fixed Expenses	3,00,500	3,00,600
Semi-fixed Expenses	97,500	1,00,500
Variable Overhead Expenses	1,45,000	1,49,500
Units made	13,500	15,000

Labour and material costs per unit are constant under present conditions. Profit margin is 10%.

- You are required to determine the differential cost of producing 1,500 units by increasing capacity to 100%.
- What would you recommend for an export price for these 1,500 units taking into account that overseas prices are much lower than indigenous prices?

(I.C.W.A., Final)

18. 50,000 units of an item are produced and sold in the home market at Rs. 50 per unit. The home market cannot absorb more than 50,000 units in a year but there is an export market for this item at Rs. 30 per unit. It is proposed to increase the production and sell the additional quantities in the foreign market at Rs. 30 per unit. The variable costs work out to Rs. 25 per unit and the fixed charges amount to Rs. 8,00,000 in a year. Calculate the number of additional units to be made and sold abroad to achieve a total profit of Rs. 6,00,000 in a year both on domestic and foreign sales together.

(I.C.W.A., Inter)

19. The production cost of a component made in your factory absorbing 30% capacity is Rs. 400 per gross. An outside supplier offers to supply adequate quantities to meet your requirement at Rs. 340 per gross. The Sales Manager recommends their purchase so that your production can be sold at 5% lower price, increasing your sales to yield 15% more profit. What would be your recommendations to the Managing Director in your report on this point?

(I.C.W.A., Final)

20. The installed capacity of a Company is one lakh units per annum. It is licensed only to produce 75% capacity. But it is given an option by the Govt. to produce upto full capacity if the Company could export and earn foreign exchange on the extra production. The operating costs at the installed capacity are :

Direct Material	..	Rs. 3 per unit
Direct Labour	..	Rs. 2
Variable Overheads	..	Rs. 3
Fixed Overheads	..	Rs. 2 lakhs per annum.

No increase in the material and labour etc. costs is anticipated during the current year.

The Company has received an overseas offer for 20,000 units which if accepted would involve an extra expenditure of Rs. 11,000 towards special packing, commission etc. If the offer materialises, the Company can obtain raw materials required for the export order at a concessional rate of 40% below the present cost.

As a Cost Accountant of the Company submit a report to your Managing Director suggesting the selling prices you recommend if the Company is to earn the same profit margin as on local sales at Rs. 12 per unit of the installed capacity

(a) before getting the export order, and

(b) after getting the export order.

State also what further safeguards or precautions you would suggest while recommending the selling prices. (I.C.W.A., Final)

21. A farmer owns an orchard which has an area of 300 acres on which he grows apples, apricots, cherries and plums. Of the total area, 200 acres of land are unsuitable for growing apples or plums and are suitable only for apricots and cherries. On the remaining 100 acres of land, any of the four fruits can be grown.

The marketing policy requires that in each season all the four types of fruits must be produced and the quantity of any one type should not be less than 12,000 boxes.

It is also essential that the area devoted to anyone should be in terms of complete acres and not in fraction of an acre. There are no physical or marketing limitations and there is an adequate supply of all types of labour.

The details regarding the selling price, production and costs are given below—

	Apples	Apricots	Cherries	Plums
Selling price per box (in Rupees)	10	10	20	30
Season yield, in boxes per acre	500	150	100	200
Weight per box (Kgs.)	30	30	40	20
Cost (Rs.)				
Material per acre	180	70	60	100
Labour -				
Growing per acre	200	150	100	130
Harvesting and packing per box	1	1	2	3
Transport per box	2	2	1	3

Fixed overhead each season—

Cultivation and growing	Rs. 28,000
Harvesting	21,000
Transport	5,000
Administration	42,000
Land and Revenue	9,000

Advise the farmer on the area to be allotted to each item in order to earn the maximum total profit and what is that total profit. (I.C.W.A., Inter)

22. Bathing Care Ltd. manufactures and sells soaps under the brand names—Elite, Lovely, Fresh and Janata. The Janata soap is very popular as it is of good quality and at the same time reasonably priced. The company produces and sells per annum on an average 50,000 cakes of Elite, 1,00,000 cakes of Lovely, 75,000 of Fresh and 2,00,000 cakes of Janata at a unit selling price of Rs. 3.50, Rs. 3.00, Rs. 2.50 and Rs. 1.50 respectively.

At this level of production and sales, the unit cost of a cake of each brand of soap is as follows—(expressed in paise)

	Elite	Lov	Fresh	Janata
Direct Material	50	40	35	45
Direct Labour	20	20	15	10
Production Expenses :				
Fixed	20	25	20	20
Variable	10	10	5	5
Administration Expenses :				
Fixed	30	40	25	30
Variable	15	5	10	5
Selling & Distribution Expenses :				
Fixed	80	60	45	10
Variable	45	20	25	5
Total Cost	270	220	180	130

The company has a lot of unutilised capacity and there is ample scope for improving production and sales volumes. Bathing Care Ltd. has built a name for its products in the market and with proper sales effort it should be possible to sell whatever is produced by the company. The Production Manager sees no problems.

The Sales Manager puts up a bold scheme for almost quadrupling the present profits of the company :

(i) An exclusive advertisement campaign has to be undertaken to promote the sale of Janata soap and this is estimated to cost Rs. 4,85,000.

(ii) At the same time, the selling price of a cake of Janata soap should be reduced to Re. 1.

By adopting this sales strategy, the Sales Manager is confident that he would be able to double the present sales volume of Janata soap and with each 1,00,000 cakes of Janata, he would be able to push the sales of 30,000 cakes of Elite, 70,000 cakes of Lovely and 50,000 cakes of Fresh in the market.

As a Cost Accountant of the Company, submit your report to the Managing Director on the feasibility of the Sales Manager's scheme with figures of the present profit and those of the future if the scheme is accepted. (I.C.W.A., Final)

23. XY Company buys crude vegetable oil. The refining of this oil results in four products A, B, C and D. The cost of oil refined in 1976 was Rs. 2,76,000 and the refining department had total processing costs of Rs. 7,00,000. The output and sales for the four products in 1976 were as follows—

Product	Output	Sales Rs.	Additional Processing cost after split off Rs.
A	5,00,000 gallons	11,50,000	3,00,000
B	10,000 gallons	1,00,000	60,000
C	5,000 gallons	40,000	—
D	9,000 gallons	3,00,000	10,000

Required—

- Assume that the net realizable value at split off is used for allocating joint costs. What is the net income for products A, B, C and D? Joint costs total Rs. 9,76,000.
- The company had been tempted to sell out at split-off directly to other processors. If that alternative had been selected, sales per gallon would have been A Rs. 1.50; B Rs. 5.00; C Rs. 8.00 and D Rs. 30. What would the net income have been for each product under this alternative?
- The Company expects to operate at the same level of production and sales in the forthcoming year. Could the Company increase net income by altering its processing decisions? If so what would be the expected overall net income? Which products should be processed further and which should be sold at split off? Assume that all costs incurred after split off are variable.

(I.C.W.A., Final)

24. The annual budget of a company at 60% and 80% levels of performance is as under :

Level of Performance	60% Rs. ('000)	80% Rs. ('000)
Direct Material	360	480
Direct Labour	480	640
Production Overhead	252	276
Administration Overhead	124	132
Selling & Distribution Overhead	136	148
	<u>1352</u>	<u>1676</u>

The company is in great difficulties at the present moment in selling its products and is now operating at 50% level.

The Sales revenue for the year is estimated at Rs. 9,90,000. The Directors are seriously considering suspending operations till the market picks up.

Market Research undertaking by the Company reveals that there is every indication that in about twelve months' time, the sales will pick up and the Company can comfortably operate at 75% level of performance and earn a sales income of Rs. 18 lakhs in that year.

The Sales personnel of the Company do not want to suspend operations for fear of adverse reactions in the market ; but the Directors want to decide the issue purely on financial considerations.

If the manufacturing and other operations of the Company are suspended for a year, it is estimated that :

- (a) the present fixed costs could be reduced to Rs. 2,20,000 per annum.
- (b) the settlement costs of personnel not required would amount to Rs. 1,50,000.
- (c) the maintenance of plant has to go on and that would cost Rs. 20,000 per annum.
- (d) on resuming operations, the costs connected with opening after a shut-down would amount to Rs. 80,000.

Submit a report to the Directors and indicate therein, based on purely financial considerations, whether it would be advisable or not to suspend the Company's operation in the current year. *(I.C.W.A., Final)*

25. A single product manufacturing company uses a sophisticated machine to produce Product 'A'. The machine can produce two units of product 'A' per hour and the raw material cost per unit is Rs. 40. The direct labour cost is Rs. 80 per hour and the variable overheads amount to Rs. 20 per hour. The selling price of the product is Rs. 160 per unit.

The Company at present spends Rs. 6,400 per month on regular maintenance. The management has observed that on an average the machine remains idle for 100 hours a month due to break down. The cost of breakdown repairs amounts to Rs. 64,000. Since there is a vast potential for the sale of an increased volume of output, the management is seized with the problem of reducing breakdown hours.

The Plant Engineer suggests that the present breakdown loss of 100 hours per month on an average can be reduced or eliminated if a scheme of additional preventive maintenance is introduced. This scheme will also bring down the breakdown repair costs as indicated below : —

Breakdown Hours	80	60	40	20	0
Preventive maintenance costs (Rs.)	12,800	25,600	51,200	1,02,400	2,04,800
Breakdown repair costs (Rs.)	51,200	38,400	25,600	19,200	—

During the stoppage of the machine, the direct labour can be utilised elsewhere in the factory productively upto 40 hours per month and beyond this the direct labour will remain idle.

Advise the management using the differential or incremental cost analysis, the level upto which the breakdown can be reduced to maximise profits consistent with effective minimum costs. *(I.C.W.A., Final)*

CHAPTER 10

COST-VOLUME-PROFIT RELATIONSHIP

Cost-Volume-Profit Analysis. The main objective of an undertaking is to earn profit. Profit depends upon a large number of factors, more important of which are the selling price of the product sold, its cost of manufacture, and the volume of sales effected. Each of these factors is inter-dependent ; selling price depends to a certain extent on cost if a desired profit is to be obtained, and volume of sales depends upon volume of production, which in turn is related to costs. Then again, cost is the resultant of the operation of a number of varying factors, such as, (i) volume of production, (ii) product mix, (iii) internal efficiency or inefficiency in production, (iv) changes in the methods of production, (v) size of order, lot, or batch of products, (vi) size of plant or factory, and (vii) the cost procedure followed like method of recovery of overhead, pricing of materials issues, method of wage payment, etc. Of all these, volume is perhaps the largest single factor which influences costs. Volume changes in a business are of frequent occurrence, often necessitated by outside factors over which management have usually no control and as costs do not always vary in proportion to changes in levels of output, managerial control of the factor of volume presents a special problem.

Objectives of Cost-Volume-Profit Analysis. From what has been stated in the foregoing paragraph, it will be seen that a close relationship exists between costs, volume, and profit. Analysis of this relationship opens up an interesting and useful field for the cost accountant. Cost-volume-profit analysis may be applied for profit planning, cost control, and decision making. The *objectives* of such an analysis are detailed below :

- (a) In order to forecast profit fairly accurately, it is essential to know the relationship between profit and costs on one hand and volume on the other.
- (b) Sales and costs (other than the fixed costs) tend to vary with the volume of output. While establishing budgets for sales and variable costs, it is necessary to budget the volume first. Cost-volume-profit analysis is useful in setting up flexible budgets which indicate costs at various levels of activity.
- (c) Cost-volume-profit analysis is of assistance in performance evaluation for purpose of control. For reviewing profits achieved and costs incurred, the effects on costs of changes in volume are required to be evaluated.
- (d) Pricing plays an important part in stabilizing and fixing up volume, particularly in periods when business is slack. Analysis of cost-volume-profit relationship may assist in formulating price policies by projecting the effect which different price structures have on costs and profits.

- (e) As predetermined overhead rates are related to a selected volume of production, study of cost-volume relationship is necessary in order to know the amount of overhead costs which could be charged to product costs at various levels of operation

Measure of Volume or Activity. Study of behaviour of costs and cost-volume-profit relationship needs proper definition of volume or activity which should be measurable with reasonable accuracy. Volume is usually expressed in terms of the following :—

- (i) Sales capacity expressed as a percentage of maximum sales
- (ii) Value of sales
- (iii) Units (or quantity) of sales
- (iv) Production capacity expressed as a percentage of maximum production
- (v) Value or cost of production
- (vi) Units (or quantity) of production
- (vii) Direct labour hours
- (viii) Direct labour value
- (ix) Machine hours

The selection of a suitable volume index presents some difficulty, particularly when the problem is to choose an over-all index to relate all items of cost in a department. The following considerations should be taken into account in the selection of a measure for volume :—

- (a) Where production can be expressed in terms of common physical units such as tonnes, kilograms, litres, numbers, etc., such a physical unit may be selected as the volume index or base
- (b) The base selected should itself be susceptible to adequate control and it should not very often change or fluctuate. Considering this aspect, standard labour hours may for example, constitute a better base than actual labour hours.
- (c) The base selected should not be affected by factors other than volume. Judged from this view point, direct labour cost is a poor index of volume as it is subject to changes due to fluctuation in the rate or price factor and the cost of living index.
- (d) A suitable volume index would be that particular activity factor which causes the specific item of cost for which the index is to be fixed, to vary with the increase or decrease in the factor. Such common bases are labour hours, weight of materials handled, number of calls made by salesmen, etc.
- (e) The base selected should be easily understood. It should avoid complications and should require the minimum clerical expenditure in its separation.

Presentation of Cost-Volume-Profit Relationship Data. Analysis of cost-volume-profit involves consideration of the interplay of several factors, viz

- (a) Selling price
- (b) Volume of sales

- (c) Product mix of sales
- (d) Variable costs per unit
- (e) Total fixed costs.

The relationship between two or more of these factors may be, (i) presented in the form of reports and statements, (ii) shown in charts or graphs, or (iii) established in the form of mathematical deductions with the help of suitable formulae.

The presentation of cost-volume-profit data in the form of statistical reports and statements under marginal costing and differential cost methods was illustrated in the previous chapter. Another illustration showing estimated profits and costs at different sales volumes is given here.

FORECAST COST-VOLUME-PROFIT ANALYSIS

Plant capacity	70%	80%	90%	100%
Sales (units)	7,000	8,000	9,000	10,000
	Rs.	Rs.	Rs.	Rs.
Price per unit	1.00	1.00	0.90	0.80
Sales value	7,000	8,000	8,100	8,000
Direct labour	700	800	900	1,000
Direct material	1,400	1,600	1,800	2,000
Factory overhead	700	800	900	1,000
Administration and selling overhead	350	400	450	500
Total variable cost	3,150	3,600	4,050	4,500
Contribution margin	3,850	4,400	4,050	3,500
Fixed factory overhead	1,000	1,000	1,000	1,000
Fixed administration and selling overhead	500	500	500	500
Total fixed cost	1,500	1,500	1,500	1,500
Profit	2,350	2,900	2,550	2,000
Margin ratio (contribution : sales)	0.55	0.55	0.50	0.44
Return on sales (profit : sales)	0.33	0.36	0.31	0.25
Capital employed	20,000	21,000	22,000	25,000
Return on capital (profit : capital employed) %	11.75	13.81	11.59	8.00
Turnover (sales : capital employed) %	35	38	37	32

Break-even Analysis. (Graphical approach) Break-even analysis may be made with the help of charts or through mathematical formulae. Charts which depict cost-volume-profit data are visual aids which serve to dramatise the effect of changes in cost, volume, and profit. Like other charts, they impress effectively and tell their stories at a glance. One such chart is the *Break-even Chart* which besides picturing on graph the total cost, fixed and variable costs, sales revenue, and the profit or loss at various volumes, shows the *Break-even Point* for the business. The break-even point is the sales volume at which there is neither profit nor loss, costs being equal to revenue.

There are numerous ways in which break-even charts are prepared depending upon the purpose which they are meant to serve and the details which they are required to exhibit. A simple break-even chart is prepared in the manner stated overleaf.

- (i) The X axis on a graph represents volume and the Y axis represents costs and revenue (sales value). Volume may be represented by one of the bases already discussed. The base is selected according to needs, usually as a percentage of stated capacity expressed in terms of sales units or sales volume. The former is more suitable if fluctuations and distortions due to price changes are to be avoided.
- (ii) The 'sales line' showing the revenue at various volumes is drawn.
- (iii) The next step is to draw the 'cost line'. This shows the cost at various volumes.
- (iv) The point where the sales and cost lines intersect is the break-even point and the volume at which this happens is the *break-even volume*. The perpendicular distance between the sales line and the cost line at a given volume, represents the profit or loss at that volume. At the break-even volume, this distance is zero indicating no profit or loss.
- (v) The angle which the sales line makes with the total cost line is known as the *angle of incidence*.

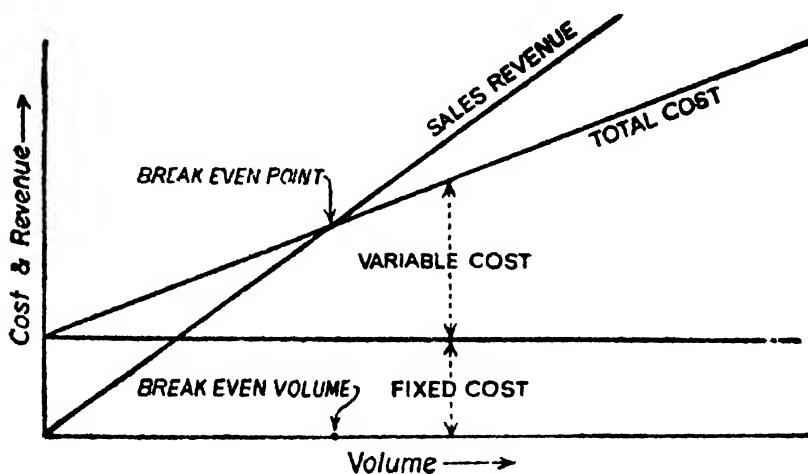


Fig 10.1. Simple Break-even Chart

A simple break-even chart is shown in Fig. 10.1. The method of drawing the chart is illustrated in the example given below.

EXAMPLE 10.1.

You are given the following data for the coming year for a factory :

Budgeted output	80,000 units
Fixed expenses	Rs. 4,00,000
Variable expenses per unit	Rs. 10
Selling price per unit	Rs. 20

Draw a break-even chart showing the break-even point.

If the selling price be reduced to Rs. 18 per unit, what will be the new break-even point?
(I.C.W. 4., Inter)

ANSWER :

On the graph (Fig. 10.2), the horizontal axis represents the various levels of budgeted output and the vertical axis represents the cost as well as sales value (revenue).

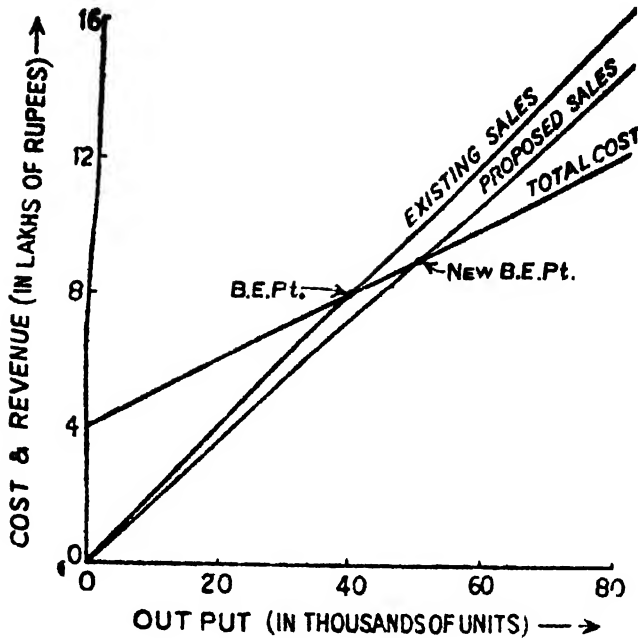


Fig. 10.2. Change in Break-even Point on Reduction of Selling Price

Variable expenses at 80,000 units	= Rs. 10	80,000	= Rs. 8,00,000
Total cost at 80,000 units	= Rs. 4,00,000	+ Rs. 8,00,000	= Rs. 12,00,000
Sales for 80,000 units	= Rs. 20	80,000	= Rs. 16,00,000

The break-even point as seen from the graph is 40,000 units.

When the selling price is reduced from Rs. 20 to Rs. 18 per unit, the new sales line is drawn by taking the total sales revenue for 80,000 as Rs. 18 × 80,000 = Rs. 14,40,000. The new break-even point as read out from the graph is 50,000 units.

We know that fixed costs remain fixed only within a specified range of activity and with change in the activity beyond that range, the fixed costs take the form of stepped costs (see Page 190). If, therefore, a break-even chart is required to cover activities over a long range, the graph will be as shown in Fig. 10.3.

Another form of the break-even chart known as the *contribution break-even chart* is given in Fig. 10.4. In this chart, the variable costs are shown first, above the base line and the contribution margin at any volume of sales may be read from this chart. The chart also clearly indicates that at all volumes below the break-even, the sales are unable to recover the fixed cost.

Detailed (or analysis) break-even charts (Fig. 10.5) may be compiled to exhibit details of the variable costs under the various elements of costs such as direct material, direct labour, variable factory overhead, variable administration, selling and distribution overhead, and the appropriations of profit to taxes dividends, reserves, etc.

Break-even charts may also be prepared in conjunction with standard costing and budgetary control systems. These charts may be termed *control break-even charts*. One such chart, is given in Fig. 10.6. Two separate lines of budgeted

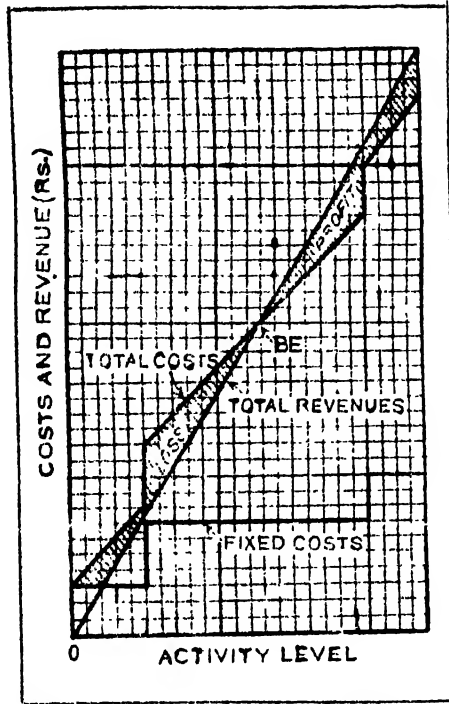


Fig. 10.3. Break-even point with stepped fixed costs

total costs, one for the budgeted sale and the other for the actual sale, are drawn. The actual profits and profit variances can be read from the chart.

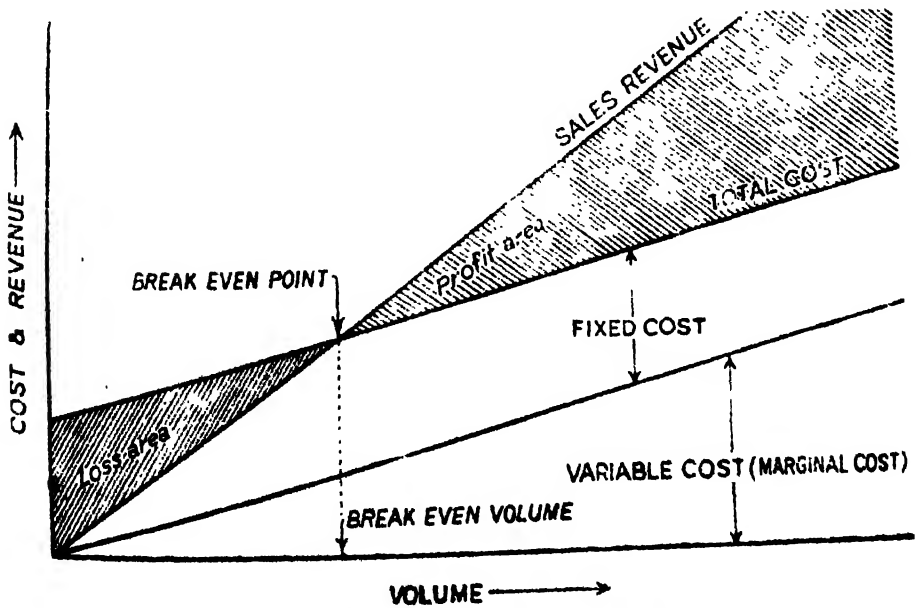


Fig. 10.4. Contribution Break-even Chart

Cash flow break-even chart is a special type of break-even chart which may be utilised to determine the volume at which cash breaks even, i.e. the point at which cash flow will be available just enough to meet the immediate cash liabilities like payment of loan, interests, taxes, preference share dividends, etc. In drawing

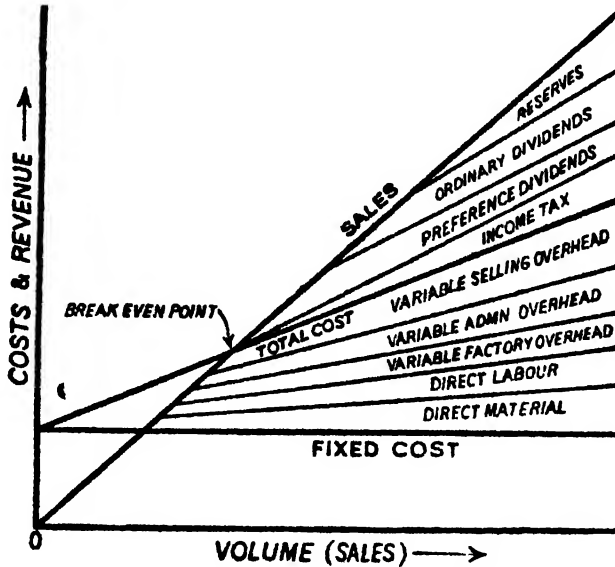


Fig. 10.5. Detailed Break-even Chart

this chart (see Fig. 10.7), the fixed costs are separated into two portions, viz. those fixed costs for which immediate cash is necessary and those which are mere adjustments like depreciation and deferred expenses for which immediate payment is not required to be made. The fixed costs requiring cash payment are plotted first, just above the base line and the second category of fixed costs is plotted last. Variable costs are assumed to need immediate cash outlay.

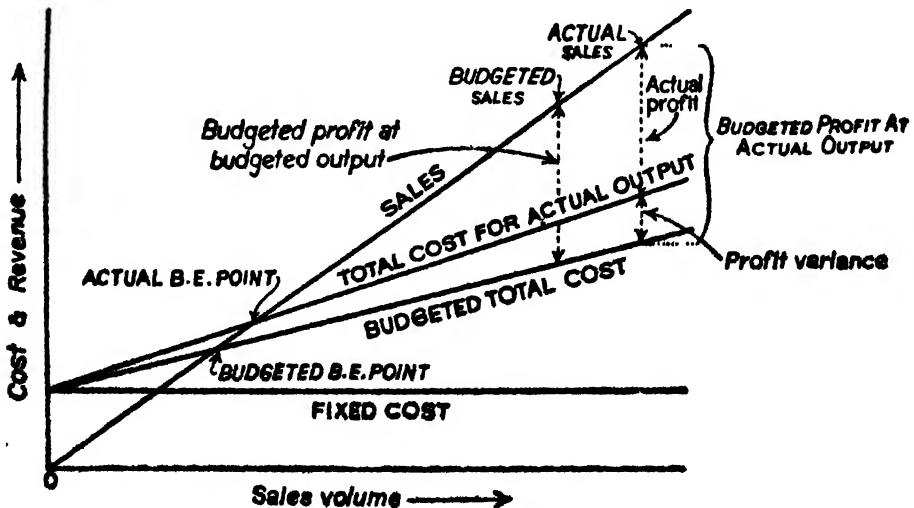


Fig. 10.6. Control Break-even Chart

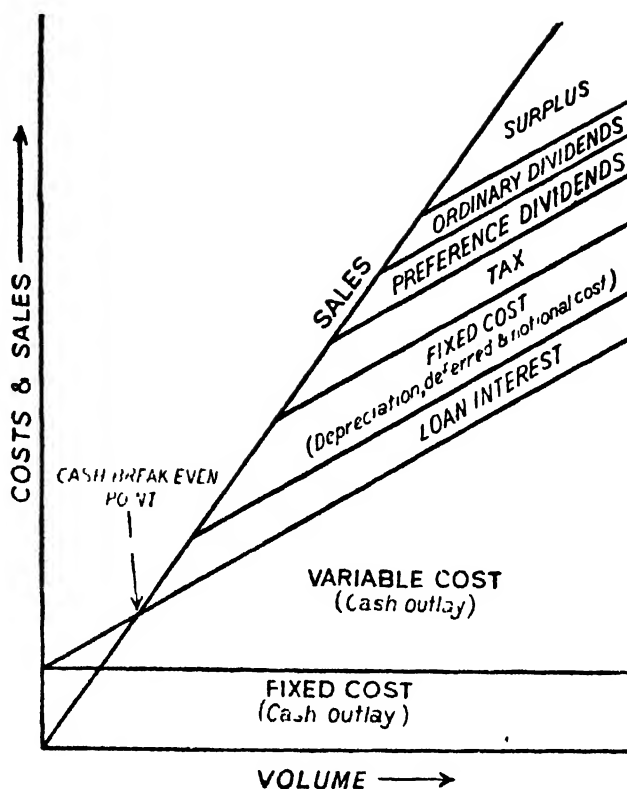


Fig. 10.7 Cash flow Break-even Chart

A per unit profit graph may be drawn to show more clearly the influence of fixed costs on the product unit cost. Such a graph has been shown in Fig. 10.8. The data assumed for the graph are as follows :—

Selling price	Rs. 400 per unit
Variable costs	Rs. 200 per unit
Total fixed costs (within the relevant range)	Rs. 5,000

Another variation of the break-even chart is a *profit-volume chart*, also called *profit-volume analysis graph*. In this chart (Fig. 10.9), the horizontal axis represents the sales volume and the vertical axis shows profit or loss. The diagonal line represents the total marginal contribution of the business. The point at which this line cuts the horizontal axis is the break-even point. The horizontal line at zero profit level represents the break-even point where there are no profits or losses.

Profit volume charts are pictorial presentations of cost-volume profit relationship and are particularly useful in, (i) determining the break-even points and showing the effect on profits of charging different prices for a product, (ii) showing in the case of multi-product situations, the effect of product mix on break-even point and profits, (iii) showing the deviations of actual performance (profit) from the planned performance, and (iv) forecasting the costs and profits which would result from changes in sales volume. Fig. 10.10 illustrates the

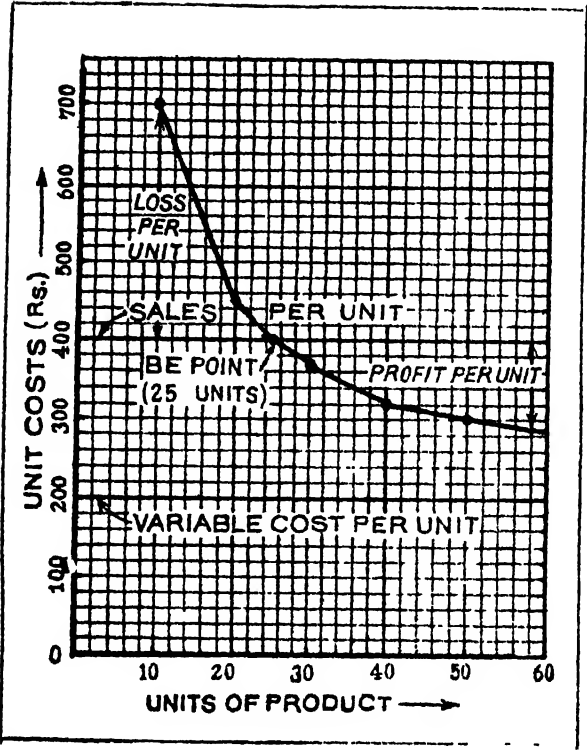


Fig. 10.8. Unit Profit-Graph

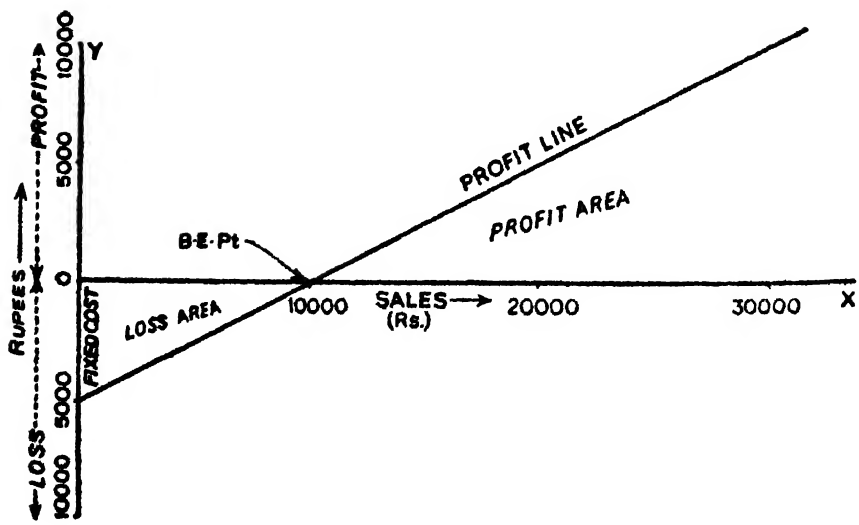


Fig. 10.9. Profit Chart

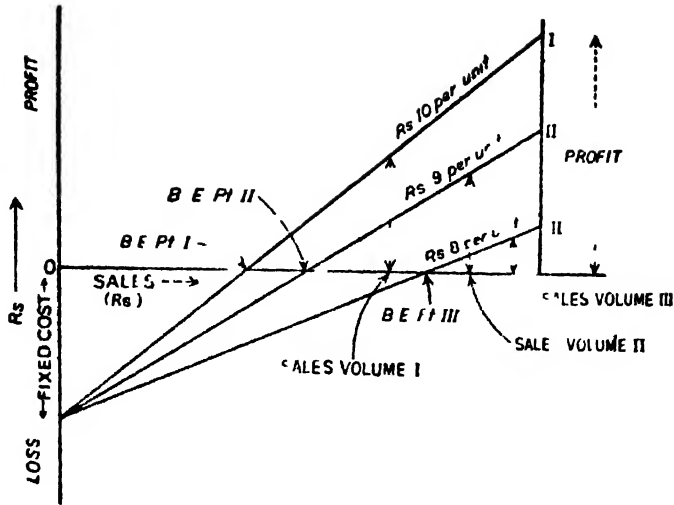


Fig 10.10 Break even Points at Different Price Levels

volume profit relationship and the break-even points and profits at the different price levels for a product. In Fig 10.11, individual break-even points for each of the six different products constituting a particular sales mix are shown. The break-even points could otherwise be obtained by compiling six different break-even charts, one for each product. It will be seen that there are no break-even points for products D, E and F. The position in respect of product I and F is all the more peculiar in as much as for product I, marginal contribution is nil, the sale value being equal to the variable cost, and in the case of product F, the contribution is a minus figure, the variable cost being more than the sale value.

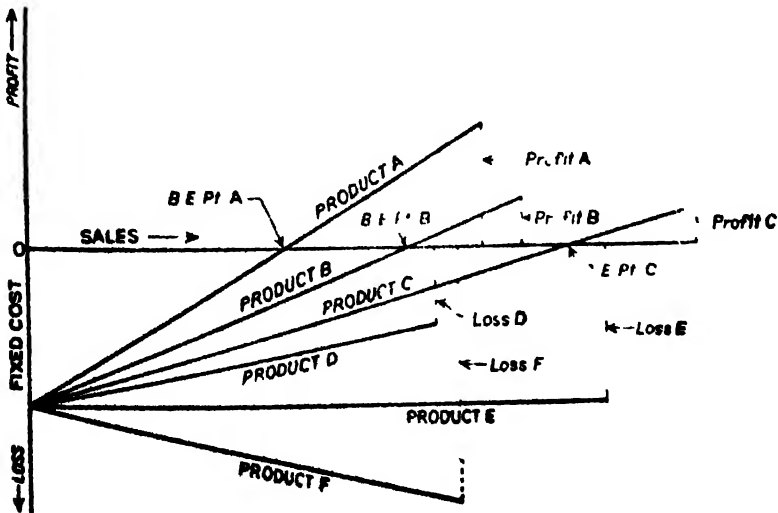


Fig. 10.11. Profit Chart showing Individual Break-even Points for Several Products

If it is desired to determine the combined or overall break-even point for a product mix instead of separate break-even points for individual products

comprising the mix, use may be made of what is called a *Profit Path Chart*. The profit path for each product is charted ; the product selected for charting first is the one with the highest P/V ratio. (P/V ratio has been discussed in a later section of this chapter.) The profit line starts from the fixed cost point and extends up to the profit points for the product. The line for the second product starts at the point where the first line ends. The charting is continued in this manner till the profit point for the last product is reached. The total profit path is the line extending from the fixed cost point to the profit point reached by the last product. The volume point where the total profit line intersects the horizontal axis (sales volume line) is the break-even point for the product mix. The method is illustrated below :

EXAMPLE 10.2.

The following figures apply to a manufacturing company producing a wide range of products which may be classified into three main groups :

<i>Product group</i>	<i>Annual sales</i> Rs.	<i>Variable cost</i> Rs.
A	30,00,000	10,00,000
B	30,00,000	20,00,000
C	35,00,000	30,00,000

The fixed costs total Rs. 25,00,000

Plot on a graph the marginal income slopes for the product group in alphabetical order to enable you to plot the average marginal income slope for the total output. (I.C.M.A., P. IV)

ANSWER :

Statistics required for plotting the graph are arrived at as follows. (Figures are in '00000 Rs.) :

<i>Product</i>	<i>Annual sales</i>	<i>Progressive sales</i>	<i>Variable cost</i>	<i>Progressive Variable cost</i>	<i>Marginal contribution (Progressive)</i>	<i>Fixed cost</i>	<i>Net profit (Progressive)</i>
	(X)						(Y)
A	30	30	10	10	20	25	(-) 5
B	30	60	20	30	30	25	5
C	35	95	30	60	35	25	10

The data (X) and (Y) are plotted on the X and Y axes respectively, on the graph (Fig. 10.12).

Break-even charts may be drawn for showing optimum output or optimum sales. In all the illustrations given above, it was assumed that costs and sales are represented by straight lines. In practice, sales may fall off at higher volumes (price might have to be reduced) and the variable costs may not vary in direct proportion to the load. In such cases, the sales values may be represented by a curve and the costs may be represented by a line of regression. The point at which the vertical distance between the sales curve and the total cost is the maximum denotes the maximum profit point and the sales volume at that point is the optimum output. This is illustrated in Examples 10.3 and 10.4.

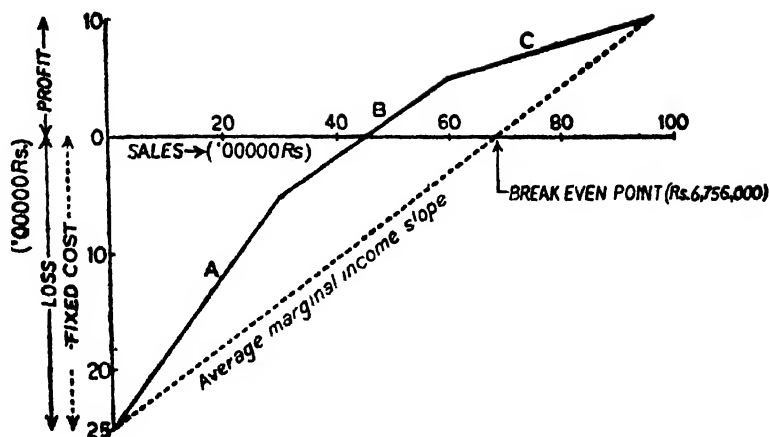


Fig 10.12 Profit Path Chart

EXAMPLE 10.3

A company manufactures a machine which is sold at Rs 10,000. In the year 1984 monthly accounts showed the following figures.

	Units made and sold	Total costs Rs ('000)	Profit Rs ('000)
January	1,500	12,000	3,000
February	1,375	10,500	3,250
March	1,200	10,000	2,000
April	1,700	12,750	4,250
May	1,300	10,750	2,250
June	1,825	13,000	5,250
July	1,100	10,000	1,000
August	825	8,500	250 (loss)
September	2,175	14,500	7,250
October	1,900	14,000	5,000
November	1,575	11,500	4,250
December	975	8,500	1,250

Present these figures graphically to show :

- the effect of volume on profit ;
- the fixed expenses of the company per month ;
- the profit-volume ratio.

(ICMA, Pt IV—Adapted)

ANSWER :

With the help of the data given, a scatter diagram is drawn (Fig 10.13). The horizontal axis represents sales volume and the vertical axis the profits (both drawn on the same scale). The point where the regression line meets the vertical axis represents the fixed cost.

- Effect of volume on profit : The profit for any volume can be read out from the graph.
- Fixed expenses : Rs. 36.25 lakhs per year, or Rs 3.02 lakhs per month.

The slope of regression line (i.e. the angle which this line makes with the horizontal axis) is 26° (approx.) if the horizontal and vertical axes are drawn on the same scale.

Therefore, profit-volume ratio $= \tan 26^\circ = 0.495 = 49.5\%$ (approx.).

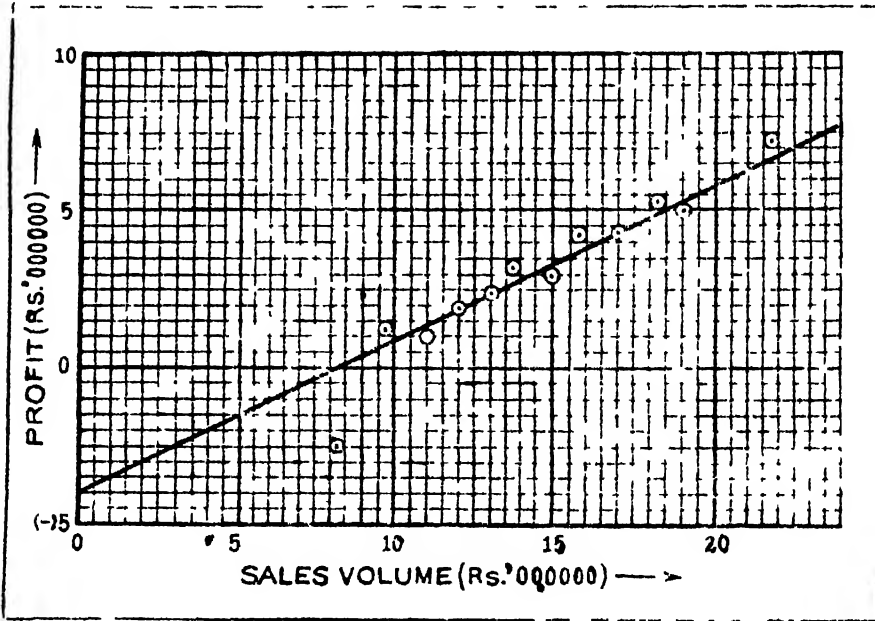


Fig. 10.13 Scatter Diagram

This may be proved as follows :

(c) Sales (Rs. lakh) Contribution (Rs. lakh)

Rs. 217.50 Rs. 72.50 Rs. 36.25

Rs. 97.50 Rs. 12.50 Rs. 36.25

Rs. 120.00

Rs. 60.00

$$P/V = \frac{\text{Rs. 60.00}}{\text{Rs. 120.00}} = 50\%$$

In place of profit, the figures for contribution could also be adopted. Thus,

$$\text{Contribution} \quad P + F = S - V$$

$$\therefore \frac{\text{Contribution}}{\text{Volume}} = \frac{S - V}{S} = \frac{P + F}{S}$$

$$= \frac{\text{Rs. 12,50,000} + \text{Rs. 36,25,000}}{\text{Rs. 97,50,000}} \approx 0.50 = 50\%$$

(d) Profit : 1,000 units
1,400 units
2,000 units

Rs. 14,00,000
Rs. 34,00,000
Rs. 62,75,000

EXAMPLE 10.4

An undertaking sells its sole product at Rs. 1,000 per metric ton at the present level of output and sales of 10,000 metric tons per year. Variable cost of production is Rs. 200 per metric ton and fixed costs amount to Rs. 100 lakhs per year. The market for the product is sufficiently elastic and the surplus capacity of the undertaking if properly utilised, can push up the output to 40,000 metric tons per year without any increase in fixed costs. Production can, however, be immediately stepped up to 50,000 metric tons per year provided an additional 50 per cent over the present fixed costs is incurred, and with this increase in the level of fixed costs, output may be increased up to 90,000 metric tons per year.

The sales department of the undertaking reports that the market demand is capable of expansion in accordance with the following price schedule.

<i>Sales</i>	<i>Sales Price</i>	<i>Sales</i>	<i>Sales Price</i>
(in thousands of metric tons)	(per metric ton)	(in thousands of metric tons)	(per metric ton)
10	Rs. 1,000	60	Rs. 900
20	Rs. 1,000	70	Rs. 850
30	Rs. 1,000	80	Rs. 725
40	Rs. 925	90	Rs. 600
50	Rs. 920		

With the help of a break-even chart determine the optimum sales volume for the product.
(ICWA Final)

ANSWER

The data for plotting the graph (Fig. 10.14) is computed as follows:

<i>Sales</i>	<i>Sales value</i>	<i>Variable costs</i>	<i>Fixed costs</i>	<i>Total costs</i>
(MT)	(Rs. in lakhs)	(Rs. in lakhs)	(Rs. in lakhs)	(Rs. in lakhs)
10,000	100	20	100	120
20,000	200	40	100	140
30,000	300	60	100	160
40,000	370	80	100	180
50,000	460	100	150	250
60,000	540	120	150	270
70,000	595	140	150	290
80,000	580	160	150	310
90,000	540	180	150	330

It will be seen from the chart that the optimum sales volume, i.e. the sales at which maximum profit is obtained is 70,000 metric tons per year.

The same result may be obtained by means of the calculations on the next page.

<i>Sales units</i> M. Tons ('000s)	<i>Sales value</i> (Rs. in lakhs)	<i>Variable cost</i> (Rs. in lakhs)	<i>Marginal contribution</i> (Rs. in lakhs)
10	100	20	80
20	200	40	160
30	300	60	240
40	370	80	290
50	460	100	360
60	540	120	420
70	595	140	455
80	580	160	420
90	540	180	360

The contribution is optimum at the level of 70,000 metric tons.

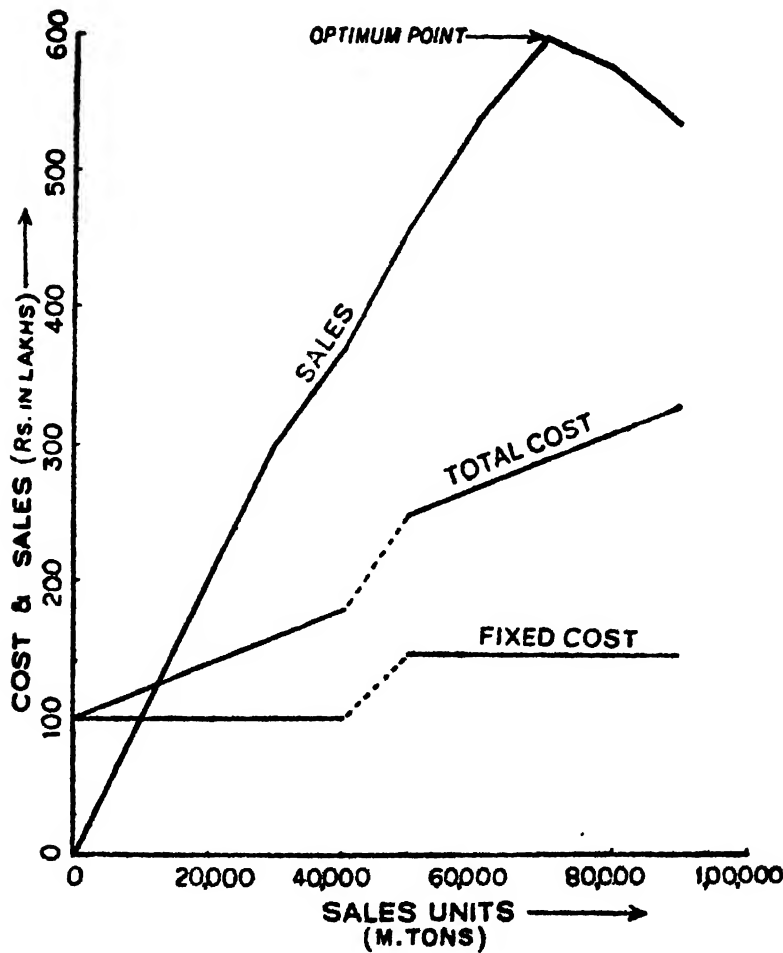


Fig. 10.14. Graph showing Optimum Level of Output.

Mathematical Relationship between Cost, Volume and Profit. Break-even analysis may be made mathematically by establishing algebraic relationship between cost, volume, and profit

If S Sales price per unit

U Total output units, i.e. volume of activity,

F Fixed cost

V Variable cost per unit

P Profit

Contribution margin $U \times S - U \times V$

Contribution margin per unit $\frac{\text{Contribution margin}}{\text{Total output units}} = \frac{U \times S - U \times V}{U} = S - V$

Contribution margin ratio (P/V ratio) $\frac{\text{Contribution margin}}{\text{Total sales revenue}} = \frac{U \times S - U \times V}{U \times S} = \frac{S - V}{S}$

Sales = Total cost + Profit = (Fixed cost + Variable cost) + Profit

or $U \times S = F + U \times V + P$

At break-even $P = 0$

$\therefore U \times S = F + U \times V$

or $U = \frac{F}{S - V}$

Thus Break-even point (in units)
$$= \frac{\text{Fixed Cost}}{\text{Sales revenue per unit} - \text{Variable cost per unit}} = \frac{\text{Fixed Cost}}{\text{Contribution margin per unit}} \quad (1)$$

If the break-even point is required in rupee sales value (i.e. $U \times S$), the calculation will be as follows

$$U = \frac{F}{S - V} \text{ (from above) or } U \times S = \frac{F \times S}{S - V} = \frac{F}{\frac{S - V}{S}}$$

But $\frac{S - V}{S}$ = Contribution margin ratio or P/V (see Page 525)

Thus, Break-even point (in rupee sales)
$$= \frac{\text{Fixed cost}}{P/V} \quad (2)$$

It may be noted that break-even point in rupee sales may also be obtained by multiplying the break-even units by the unit sale price. This calculation by the short cut method will not, however, be possible if unit price and unit variable costs are not available and where the company needs overall break-even sales for a variety of products manufactured and sold by it

Formula (1) may also be derived from the break-even chart as follows :

If y_1 Sales revenue

y_2 Total cost

a_1 = Sales per unit of volume (This represents the slope of the sales line)

a_2 = Variable cost per unit of volume (This represents the slope of the cost line)

x = Volume in units

F = Fixed cost

The sales line in the break-even chart may be represented by the equation $y_1 = a_1x$, and the costs line may be represented by the equation, $y_2 = a_2x + F$

When the business breaks even, Sales = Costs, i.e. $y_1 = y_2$ or $a_1x = a_2x + F$

$$\text{or } x = \frac{F}{a_1 - a_2}$$

$$\text{i.e., break-even volume in units} = \frac{\text{Fixed Cost}}{\text{Sales per unit of volume minus variable cost per unit of volume}}$$

$$= \frac{\text{Fixed cost}}{\text{Contribution margin per unit}}$$

The application of the above formulae is illustrated in the example given below :

EXAMPLE 10.5.

From the following data, calculate :

- (i) Break-even point expressed in units and in amount of sales in rupees.
 - (ii) Number of units that must be sold to earn a profit of Rs. 6,00,000 per year.
- | | |
|-----------------------------|---|
| Sales price | Rs. 20 per unit |
| Variable manufacturing cost | Rs. 11 per unit |
| Variable selling cost | Rs. 3 per unit |
| Fixed factory overhead | Rs. 5,40,000 per year |
| Fixed selling cost | Rs. 2,52,000 per year (I.C.W.A., Final) |

ANSWER :

- (i) Sales = Variable cost + Fixed cost + Profit

If u be the units for break-even,

$$\text{Rs. } 20 \times u = \text{Rs. } (11 + 3) \times u + \text{Rs. } (5,40,000 + 2,52,000) + 0$$

Therefore, $u = 1,32,000$ units, which is equal to $1,32,000 \times \text{Rs. } 20 = \text{Rs. } 26,40,000$ of sales.

Or taking the variable cost as percentage of sales (here, 70%) and x as the sales volume at break-even,

$$1.0x - 0.7x = \text{Rs. } 7,92,000$$

Therefore $x = \text{Rs. } 26,40,000$

or, Applying formula (1) on Page 527,

$$\text{Break-even point} = \frac{\text{Fixed Costs}}{\text{Contribution margin per unit}} = \frac{5,40,000 + 2,52,000}{20 - (11 + 3)}$$

$$= \frac{7,92,000}{9} = 88,000 \text{ units}$$

This is equivalent to Rs. 26,40,000 of sales.

- (ii) If V be the number of units required to earn a profit of Rs. 6,00,000 per year.

$$\text{Rs. } 20 \times V = \text{Rs. } 14 \times V + \text{Rs. } 7,92,000 + \text{Rs. } 6,00,000$$

Therefore, $V = 2,32,000$ units.

Profit-volume Ratio (P/V Ratio). Earlier we had referred to the method of determining the relationship between cost, volume, and profit by means of the *Profit-volume Ratio* (P/V ratio). This ratio is also known as *contribution margin ratio*, *marginal income ratio*, *contribution to sales ratio*, or *variable profit ratio*. P/V ratio (usually expressed as a percentage) is the rate at which contribution margin increases with the increase in volume.

The formulae for P/V ratio are

$$P/V = \frac{\text{Contribution margin}}{\text{Sales}}$$

$$\frac{\text{Sales} - \text{Variable cost}}{\text{Sales}}$$

$$= 1 - \frac{\text{Variable cost}}{\text{Sales}}$$

With the help of the formulae the variable cost and break-even point can be computed if P/V ratio is known.

In the profit chart (Fig 10.9), P/V is represented by the slope of the profit line. This can be worked out directly from the chart as shown below :

Sales		Contribution	
Rs 15 000		Rs 3 000	Rs 5,000
Rs 25,000		Rs 7,000	Rs 5,000
Rs 10 000		Rs 4 000	
Change in contribution, (P)		Rs 4 000	
Change in sales value (V)		- Rs 10 000	●
P/V	$\frac{\text{Rs 4 000}}{\text{Rs 10 000}}$	40%	

P/V ratio is a useful guide to the management for determining the profit changes which result from changes in volume. The profitability of small individual sectors of the business such as product lines, sales areas, salesmen, methods of sales, and classes of customers may be compared with the help of this ratio. P/V ratio for individual firms is one of the important ratios selected for inter-firm comparison. A high P/V ratio for a business indicates that a slight increase in volume without any increase in the fixed cost would result in higher profits. This would be a pointer to increased sales promotion efforts for increasing volume. The P/V formula may also be used for determining the desired volume of output for a specified amount of profit. In a product mix the profit margin on the various products may be easily studied without taking costs and prices separately into account. A product with low P/V ratio indicates low profitability so that efforts may be made to increase or improve the P/V ratio by raising the sale price of the product, or by reducing variable and direct costs. Profitability may also be improved by concentrating on the manufacture of only those products which show a high P/V ratio. It should be noted that P/V ratio is not affected by any decrease in fixed overhead, although any such decrease would increase the total profit.

Like many other ratios, P/V ratio should not be taken in isolation as by itself it does not give much information. As costs are not relevant in the calculation of P/V ratio, erroneous conclusions may be arrived at by a mere reference to the P/V ratio only.

Margin of Safety. Sales beyond the break-even volume bring in profits. Such sales represent a margin of safety expressed as a ratio or percentage M/S , where M =Margin and S =Sales value.

M = Actual total sales *minus* Sales at break-even point

$$M/S(\%) = \frac{\text{Actual sales} - \text{Sales at break-even}}{\text{Sales}} \times 100$$

If actual and break-even sales are Rs. 50,000 and Rs. 40,000 respectively, margin of safety on total sales is,

$$\frac{\text{Rs. 50,000} - \text{Rs. 40,000}}{\text{Rs. 50,000}} \times 100 = 20\%$$

When computation of margin of safety is required for planning, budgeted sales are substituted for actual sales in the formula.

The soundness of a business may be gauged by the size of the margin of safety. A high margin of safety shows that the break-even point is much below the actual sales so that even if there is a fall in sales, there will still be a profit. A small margin, on the other hand indicates a difficult position. If a low margin of safety is accompanied by high fixed cost and high contribution margin ratio, action is called for reducing the fixed cost or increasing sales volume. But if the margin of safety as well as the contribution ratio are low (the fixed cost being reasonable), the situation requires that efforts should be made towards reducing the variable cost or an increase in the selling price should be effected.

If F = fixed cost, V = output volume (units) and v = variable cost per unit, we have

$$M/S = S - B.E. \text{ point} = S - \frac{FS}{S - v} \quad \dots (a)$$

$$P/V = \frac{S - v}{S}, \text{ i.e. } \frac{S}{S - v} = \frac{1}{P/V}$$

$$\text{or } \frac{FS}{S - v} = \frac{F}{P/V} \quad \dots (b)$$

Substituting the value of $\frac{FS}{S - v}$ as obtained from (b) in (a), we have

$$M/S = S - \frac{F}{P/V}$$

Another method of expressing the margin of safety is as follows :

Margin of safety $\times P/V$ ratio = Profit, or $M/S \times P/V = P$

$$M/S = \frac{P}{P/V}$$

If net profit is 10% and P/V ratio is 50%, margin of safety will be, $\frac{0.10}{0.50} = 0.20$ or 20%

The margin of safety may be improved by taking the following steps :—

- (i) Lowering fixed costs ;
- (ii) Lowering variable costs so as to improve marginal contribution ;
- (iii) Increasing volume of sales, if there is available capacity ;
- (iv) Increasing selling price, if the market permits ;
- (v) Changing the product mix so as to improve contribution.

(a) the profit/volume ratio, to reflect the rates of growth for profit and for sales ; and

(b) any other cost figures to be deducted from the data. (I.C.M.A., Final—Adapted)

ANSWER :

	Sales (S)	Variable costs (V)	Contribution	Fixed costs (F)	Total costs	Profit (P)
1984	Rs. 39,00,000	Rs. 27,30,000	Rs. 11,70,000	Rs. 7,50,000	Rs. 34,80,000	Rs. 4,20,000
1985	Rs. 43,00,000	Rs. 30,10,000	Rs. 12,90,000	Rs. 7,50,000	Rs. 37,60,000	Rs. 5,40,000

Rs. 4,00,000

Rs. 2,80,000

$$(\text{Variable cost}) = \frac{\text{Rs. } 2,80,000}{\text{Rs. } 4,00,000} = \text{Rs. } 0.7 \text{ per rupee of sales}$$

$$(a) \text{ Profit volume ratio } = \frac{(S - V)}{S}$$

$$1984 \quad \frac{\text{Rs. } 11,70,000}{\text{Rs. } 39,00,000} \times 100 = 30\%$$

$$1985 \quad \frac{\text{Rs. } 12,90,000}{\text{Rs. } 43,00,000} \times 100 = 30\%$$

(b) Other figures are :

Break-even point $F \div P/V$

$$= \frac{\text{Rs. } 7,50,000}{30\%} = \text{Rs. } 25,00,000$$

Margin of safety = Sales - B.E. point, or $S - F \div P/V$

$$1984 - \text{Rs. } 39,00,000 - \text{Rs. } 25,00,000 = \text{Rs. } 14,00,000$$

$$\text{or } = \frac{\text{Rs. } 4,20,000}{30\%} = \frac{\text{Rs. } 4,20,000}{30} \times 100 = \text{Rs. } 14,$$

$$1985 - \text{Rs. } 43,00,000 - \text{Rs. } 25,00,000 = \text{Rs. } 18,00,000$$

$$\text{or } = \frac{\text{Rs. } 5,40,000}{30\%} = \text{Rs. } 18,00,000$$

Fixed Cost
Sales :

$$1984 - \frac{\text{Rs. } 7,50,000}{\text{Rs. } 39,00,000} = 19\%$$

$$1985 - \frac{\text{Rs. } 7,50,000}{\text{Rs. } 43,00,000} = 17\%$$

Net Profit
Sales :

$$1984 - \frac{\text{Rs. } 4,20,000}{\text{Rs. } 39,00,000} = 10.8\%$$

$$1985 - \frac{\text{Rs. } 5,40,000}{\text{Rs. } 43,00,000} = 12.6\%$$

EXAMPLE 10.8.

The sales turnover and profit during two periods were as follows :

	Sales	Profit
Period 1	Rs. 20 lakhs	Rs. 2 lakhs
Period 2	Rs. 30 lakhs	Rs. 4 lakhs

Calculate :

(i) P/V ratio, and

(ii) the sales required to earn a profit of Rs. 5 lakhs,

(J.C. W.A., Inter)

ANSWER :

	Sales	Profit
(i) Period 1	Rs 20 lakhs	Rs 2 lakhs
Period 2	Rs 30 lakhs	Rs 4 lakhs
Difference	Rs 10 lakhs	Rs 2 lakhs
P/V ratio	$= \frac{\text{Rs. 2 lakhs}}{\text{Rs 10 lakhs}} = 20\%$	
(ii) Fixed cost, Period 2		
Contribution = 20% of Rs 30 lakhs		Rs 6 lakhs
Less Profit		Rs 4 lakhs
Fixed costs		Rs 2 lakhs
P/V	$= \frac{\text{Fixed cost} + \text{Profit}}{\text{Sales value}}$	
or Sales value	$= \frac{\text{Fixed cost} + \text{Profit}}{P/V}$	
	$= \frac{\text{Rs 2 lakhs} + \text{Rs 5 lakhs}}{20\%} = \text{Rs 35 lakhs}$	

EXAMPLE 10.9

A company has annual fixed costs of Rs 1,40,000. In 1983 sales amounted to Rs 6,00,000, as compared with Rs 4,50,000 in 1982 and profit in 1983 was Rs 42,000 higher than that in 1982.

- At what level of sales does the company break even?
- Determine profit or loss on a forecast sales volume of Rs 8,00,000.
- If there is a reduction in selling price by 10% in 1984 and the company desires to earn the same amount of profit as in 1983, what would be the required sales volume?

(C U, M Com)

ANSWER :

- P/V ratio $= \frac{\text{Rs 42,000}}{\text{Rs 6,00,000} - \text{Rs 4,50,000}} = 28\%$
 B.E. Sales $= \frac{\text{Fixed cost}}{P/V} = \frac{\text{Rs 1,40,000}}{28\%} = \text{Rs 5,00,000}$
- Contribution for sales volume of Rs 8,00,000
 $= P/V \times S = 28\% \times \text{Rs 8,00,000} = \text{Rs 2,24,000}$
 Profit $= \text{Rs 2,24,000} - \text{Rs 1,40,000} = \text{Rs 84,000}$
- Contribution in 1983 $= 28\% \times \text{Rs 6,00,000} = \text{Rs 1,68,000}$

This has to be maintained in 1984

In 1984, the sales volume and contribution consequent upon 10% reduction in price are
 Rs 6,00,000—10% of Rs 6,00,000 = Rs 5,40,000 and
 Rs 1,68,000—10% of Rs 6,00,000 = Rs 1,08,000 respectively

$$P/V = \frac{\text{Rs 1,08,000}}{\text{Rs 5,40,000}} = 20\%$$

The required sales volume for earning contribution of Rs 1,68,000 is, therefore,

$$\frac{\text{Rs 1,68,000}}{20\%} = \text{Rs 8,40,000}$$

Multiple Products and Cost-Profit Analysis. So far we have discussed the cost-volume-profit relationship in firms manufacturing a single product. Where a firm produces multiple products, the total profits would depend upon :

- (i) the sales mix ;
- (ii) the sales volume selling price and variable costs per unit for each product ; and
- (iii) the total fixed costs for the period, of all products.

In case of multiple products, two types of sales mix may arise, viz. (i) where the units sold of each product are in the same proportion, e.g. 50% of product X and 50% of product Y (ratio 1 : 1) and (ii) where the units sold of the various products are not in the same proportion, e.g. 60% of product X and 40% of product Y (ratio 3 : 2).

Where the sales mix consists of individual products in the same proportion, cost-volume-profit analysis is made by calculating the average sales price per unit, and average variable costs per unit in order to obtain the average contribution margin and the average P/V ratio, as illustrated below :

	Sales mix			Total units in sales mix	Average for the sales mix
	1 unit X	1 unit Y	Total		
Per unit :					
Sales price	Rs. 12	Rs. 10	Rs. 22	2	Rs. 22 ÷ 2 = Rs. 11
Variable cost	Rs. 8	Rs. 7	Rs. 15	2	Rs. 15 ÷ 2 = Rs. 7.5
Contribution margin	Rs. 4	Rs. 3	Rs. 7	2	Rs. 7 ÷ 2 = Rs. 3.5
P/V	4/12	3/10	7/22		

Total Fixed cost Rs. 1,00,000 per year

With the data given above, break-even point (in sales units)

$$= \frac{\text{Rs. 1,00,000 (Total Fixed Costs)}}{\text{Rs. 3.5 (Average contribution margin per unit of sales mix)}} = 28,570 \text{ units}$$

Since the sales of the two products are in equal proportion, the break-even points of each will be :

	Units	Rupees
Product X :	14,285 units or $14,285 \times \text{Rs. 12}$	Rs. 1,71,420
Product Y :	14,285 units or $14,285 \times 10$	Rs. 1,42,850
	<u>28,570 units</u>	<u>Rs. 3,14,270</u>

The break even point in rupee sales for the sales mix may also be obtained directly as follows :

$$\text{Break-evenpoint (rupees)} = \frac{\text{Rs. 1,00,000 (Total fixed cost)}}{7/22 \text{ (P/V ratio for the sales mix)}} = \text{Rs. 3,14,286}$$

In the other situation when the products in the sales mix are not in the same proportion, analysis is made by computing the weighted averages. If for

instance the sales mix in the above example is changed to 3 units of X and 2 units of Y, the calculations will be made as follows :—

	Sales Mix			Total units in Sales mix	Average for the Sales mix
	3 units X	2 units Y	Total		
Sales	Rs. 36 (Rs. 12 × 3)	Rs. 20 (Rs. 10 × 2)	Rs. 56	5 (3 + 2)	Rs. 11.2 (Rs. 56 ÷ 5)
Variable costs	Rs. 24 (Rs. 8 × 3)	Rs. 14 (Rs. 7 × 2)	Rs. 38	5	Rs. 7.6 (Rs. 38 ÷ 5)
Contribution margin	Rs. 12	Rs. 6	Rs. 18	5	Rs. 3.6 (Rs. 18 ÷ 5)
P/V ratio	12/36	6/20	18/56		
Fixed cost Rs. 1,00,000 per year					

$$\text{Break-even point (in units)} = \frac{\text{Rs. 1,00,000}}{\text{Rs. 3.6}} = 27,778 \text{ (rounded off)}$$

Break-even points for individual products are :

	Units		Rupees
Product X	$\frac{27,778}{5} \times 3 = 16,667$	$\times \text{Rs. 12}$	$= \text{Rs. 2,00,004}$
Product Y	$\frac{27,778}{5} \times 2 = 11,111$	$\times \text{Rs. 10}$	$= \text{Rs. 1,11,110}$
	<u>27,778 units</u>		<u>Rs. 3,11,114</u>

If directly calculated, break-even point in rupees for the sales mix

$$\frac{\text{Rs. 1,00,000}}{18/56} = \text{Rs. 3,11,111}$$

Another example to illustrate the calculation of overall break-even point for a multiple product company is given below :

EXAMPLE 10.10.

(a) Alcos Ltd. manufacture and sell four type of products under the brand names A, B, C and D. The sales mix in value comprises 33½%, 41½%, 16½% and 8½% of A, B, C and D respectively. The total budgeted sales (100%) are Rs. 60,000 per month. Operating costs are :

Variable costs—

Product A	60% of selling price
B	68% of selling price
C	80% of selling price
D	40% of selling price

Fixed cost—Rs. 14,700 per month.

Calculate the break-even point for the products on an overall basis.

(b) It has been proposed to change the sales mix as follows, the total sales per month remaining Rs. 60,000.

Product A	25%
B	40%
C	30%
D	5%

Assuming that the proposal is implemented, calculate the break-even point.

(I.C.W.A., Final)

ANSWER :

(a)	Product A	Product B	Product C	Product D	Total
Sales mix	33 $\frac{1}{3}$ %	41 $\frac{1}{3}$ %	16 $\frac{2}{3}$ %	8 $\frac{1}{3}$ %	100%
	Rs.	Rs.	Rs.	Rs.	Rs.
Sales	20,000	25,000	10,000	5,000	60,000
Variable cost	12,000	17,000	8,000	2,000	39,000
Marginal contribution					21,000
P/V ratio	21,000/60,000 = 7/20				

$$\text{Break-even point} = \frac{\text{Fixed cost}}{\text{P/V ratio}} = \frac{\text{Rs. 14,700}}{7/20} = \text{Rs. 42,000 of sales.}$$

(b) The revised contribution on change of sales mix is as follows :

	A	B	C	D	Total
Sales mix	25%	40%	30%	5%	100%
Sales value	15,000	24,000	18,000	3,000	60,000
Variable cost	9,000	16,320	14,400	1,200	40,920
Marginal contribution					19,080
P/V ratio = 19,080/60,000 =	159/500				

$$\text{Break-even point} = \frac{\text{Rs. 14,700}}{159/500} = \text{Rs. 46,226 of sales}$$

Uses and Applications of Break-even Analysis and Profit Charts. From the illustrations given in the foregoing pages, the practical applications of cost-volume-profit analysis would now be apparent. A few more examples have been given towards the end of this chapter. It may, however, be useful to summarise here the important uses to which cost-volume-profit analysis and break-even and profit charts may be put to. These are :

- (1) Forecasting costs and profits as a result of change in volume. Determination of costs, revenue, and variable cost per unit at various levels of output.
- (2) Fixation of sales volume level to earn or cover a given revenue, return on capital employed, or rate of dividend.
- (3) Determination of effect of change in volume due to plant expansion or acceptance of order, with or without increase in costs or in other words, determination of the quantum of profit to be obtained with increased or decreased volume of sales.
- (4) Determination of comparative profitability of each product line, project, or profit plan.

- (5) Suggestions for shift in sales mix.
- (6) Determination of optimum sales volume.
- (7) Evaluating the effect of reduction or increase in price, or of price differentiation in different markets.
- (8) Highlighting the impact of increase or decrease in fixed and variable costs on profit.
- (9) Studying the effect of costs having a high proportion of fixed costs and low variable costs and vice-versa.
- (10) Inter-firm comparison of profitability.
- (11) Determination of sale price which would give a desired profit or break-even.
- (12) Determination of the cash requirements at a desired volume of output, with the help of cash break-even charts.
- (13) Break-even analysis emphasizes the importance of capacity utilisation for achieving economy
- (14) During severe recession, the comparative effects of a shut-down or continued operation at a loss is indicated.
- (15) The effect on total cost of a change in the fixed overhead is more clearly demonstrated through break-even charts.

Provided all other factors remain unchanged, a change in the fixed cost alters the break-even point by an equal percentage. If for instance, the variable cost per unit, selling price per unit, and fixed cost be Re. 0.75, Re. 1.00, and Rs. 50,000 respectively, the business will break-even at 2,00,000 units as shown below :

Sales 2,00,000 units		
@ Re. 1.00 unit		Rs. 2,00,000
Cost :		
Variable (@ Re. 0.75 per unit)	Rs. 1,50,000	
Fixed	Rs. 50,000	
	-----	Rs. 2,00,000

If fixed cost increases by 50%, the break-even point will be at 3,00,000 units
(2,00,000 + 50% of 2,00,000)

Sales 3,00,000 units		
@ Re. 1.00 per unit		Rs. 3,00,000
Cost :		
Variable (@ Re. 0.75 per unit)	Rs. 2,25,000	
Fixed	Rs. 75,000	
	-----	Rs. 3,00,000

- (16) The conditions of a business such as profit potentialities, requirements of capital, financial stability and incidence of fixed and variable costs can be gauged from a study of the position of the break-even point and the angle of incidence in the break-even chart. Four situations are discussed below :
 - (a) *Low break-even point and large angle of incidence* : The position (see Fig. 10.15) shows that fixed costs are low and margin of safety is high denoting financial stability. Some monopolistic condition exists and

high profits are earned over a large range of production activity provided sales price has not to be reduced due to elasticity of demand.

- (b) *Low break-even point and small angle of incidence* : The position is like that in (a) above except that monopolistic tendencies are absent and though profits are earned over a wide range, their extent is not high.
- (c) *High break-even point and large angle of incidence* : The fixed costs are high and margin of safety is low. The business is unstable and a small fall in activity may have disastrous results—heavy losses may be incurred. A slight increase in the volume of production or sales will, however, give a high profit due to the large angle of incidence.
- (d) *High break-even point and small angle of incidence* : This is the worst of the four situations. Fixed costs are high and margin of safety is low. The business is not financially sound and even a small decrease in production will result in loss.

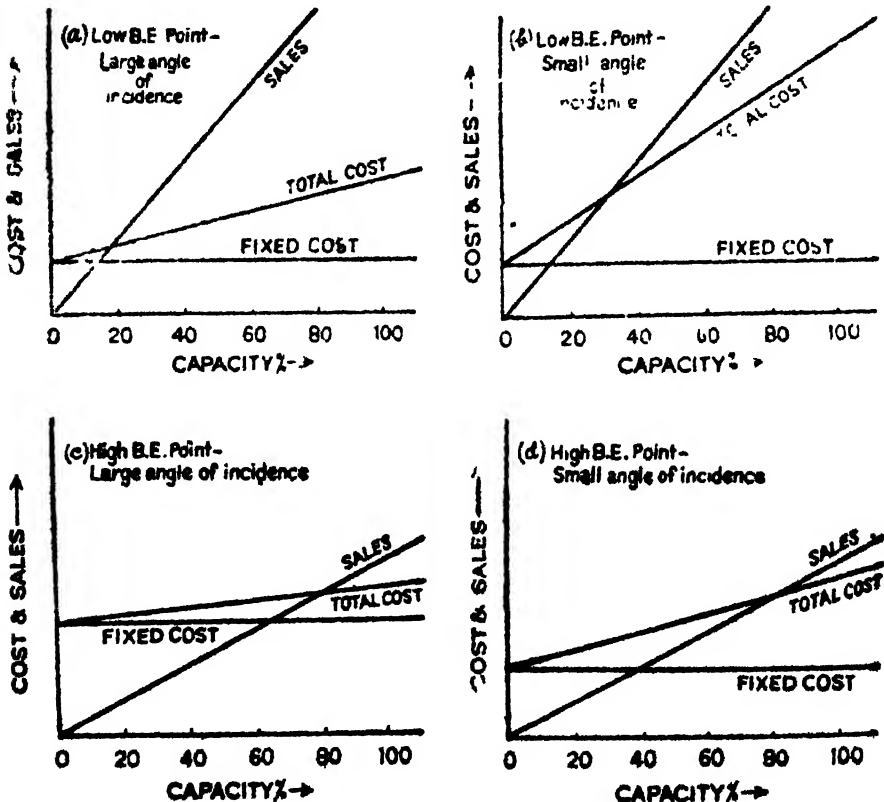


Fig. 10.15. Break-even Charts for Different Business Conditions

Limitations of Break-even Analysis (Assumptions made). Break-even charts sometimes bring in fallacious mathematical relationships where the purpose could as well be served by a suitable tabulation of the data. Further, the charts do

not convey the entire picture and supplementary information or annotation is required to explain the point. As for instance, break-even charts fail to determine the return on capital employed although the profit to sales ratio can be determined. But the main criticism arises from the fact that a number of assumptions are made in computing the break-even point or drawing the break-even charts which limit their accuracy and the break-even point as determined is only approximate. The assumptions are as follows :—

- (i) *That costs are either fixed or variable and all costs are clearly segregated into their fixed and variable elements.* This cannot possibly be done accurately and the difficulties and complications involved in such a segregation (discussed in an earlier chapter) make the break-even point inaccurate.
- (ii) *That the behaviour of both costs and revenue is not entirely related to changes in volume.* Costs and revenue depend upon several other factors besides volume and the cost and revenue lines drawn in relation to volume are not always straight lines. For example, costs and revenue may be affected by inflation which is not related to volume.
- (iii) *That costs and revenue patterns are linear over levels of output being considered.* In practice this is not always so and the linear relationship is true only within a short run relevant range. Further, a change in price may result in an increase or decrease in volume and vice-versa.
- (iv) *That fixed costs remain constant and variable costs vary in proportion to the volume.* Fixed costs are constant only within a limited range and are liable to change at varying levels of activity and also over a long period, particularly when additional plants and equipments are introduced. All variable costs are not directly proportionate to output. For example, rates of increase in overtime, discount for bulk sales, and some items of distribution costs are faster than the increase in volume.
- (v) *That sales mix is constant or only one product is manufactured.* A combined analysis taking all the products of the sales mix does not reflect the correct position regarding individual products. No doubt, the overall effect of a particular sales mix can be determined by means of profit charts (Fig. 10.9) but where more than one product is involved, average profit path may be drawn. (Fig. 10.12).
- (vi) *That production and sales figures are identical or the change in opening and closing stocks of the finished product is not significant.* As this is not always so, all fixed cost incurred during the period under consideration cannot be deducted from the revenue for that period.
- (vii) *That the units of production on the various product lines are identical.* Otherwise, it is difficult to find a homogeneous factor to represent volume.
- (viii) *That the activities and productivity of the concern remain unchanged during the period of study.* In fact, an organisation worth its name will be, at one time or the other, in a condition of growth and expansion.

- (ix) *That as output is continuously varied within a limited range, the contribution margin remains relatively constant.* This is possible mainly where the output is more or less homogeneous as in the case of process industries. Thus cost-volume-profit analysis is simpler in application in processing firms in contrast to jobbing industries with diversified orders and products.

Curvilinear Cost-Volume-Profit Analysis. As stated above, one of the important assumptions in cost-volume-profit analysis is that unit selling prices and unit variable costs are constant and so the break-even chart drawn on this assumption always depicts straight lines. If the selling price per unit is changed to increase sales volume (or decrease it, as the case may be), or the variable costs per unit increase due to diminishing returns as sales volume goes up beyond a range, the break-even chart takes a curvilinear form.

The economist's concepts relating to cost-volume-profit analysis are that : (i) marginal cost represents the change in the aggregate costs if the volume of output is changed by one unit, (ii) as selling price is reduced, demand increases, though the relationship between the two may not necessarily be rectilinear, and (iii) as the volume of production increases, the total costs increase, first at a declining rate, then at a constant rate for a long range due to economies of scale, and thereafter at an increasing rate to give diminishing return due to setting in of operational inefficiencies etc. A break-even chart based on these concepts is shown in Fig. 10.16.

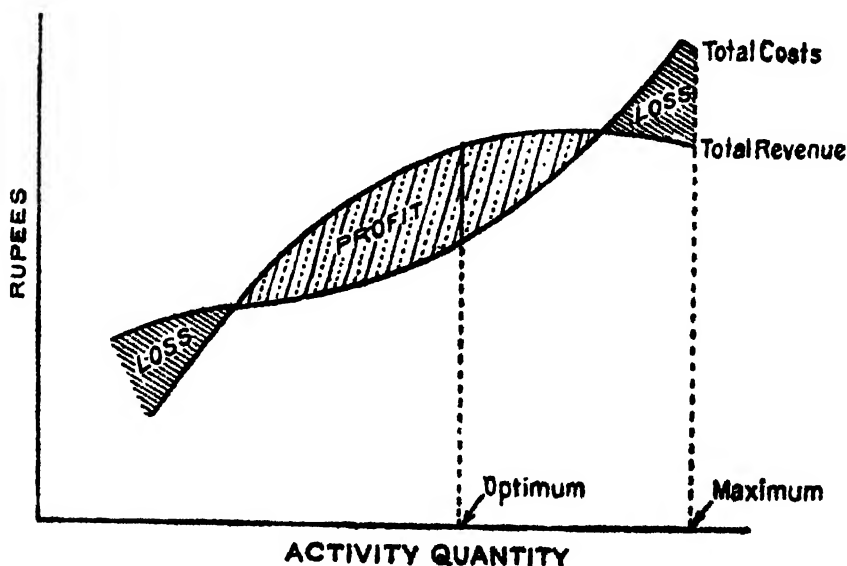


Fig. 10.16. Curvilinear Break-even Chart

It may be noted that the economist's analysis takes into account a long range view of the situation. The accountant's analysis on the other hand, makes a study of the short-term situation within a limited range. When broken up into small short term ranges, there is basically no difference between the economist's curvilinear and the accountant's rectilinear models.

Some more examples illustrating the use of cost-volume-profit analysis and break-even charts for solving specific managerial problems are given below :

EXAMPLE 10.11 (Increase in fixed and variable costs)

The following figures are extracted from the books of a manufacturing concern for the year 1961-62.

Direct materials	.. ..	Rs. 2,05,000
Direct labour	.. ..	Rs. 75,000
Fixed overheads	.. ..	Rs. 60,000
Variable overheads	.. ..	Rs. 1,00,000
Sales	.. ..	Rs. 5,00,000

Represent each of the above figures graphically on a break-even chart and determine from the chart the break-even point making necessary assumptions. Show on the graph the effect on break-even point of an increase of 10 per cent in (a) fixed expenses and (b) variable expenses. Verify calculation. (I.C.W.A., Final)

ANSWER :

$$\text{Break-even volume} = \frac{\text{Total fixed cost}}{1 - \frac{\text{Total variable cost}}{\text{Total sales}}} = \frac{60,000}{1 - \frac{3,80,000}{5,00,000}} = \text{Rs. 2,50,000}$$

(a) With increase of fixed expenses :

Revised fixed cost = Rs. 66,000

$$\text{Revised break-even volume} = \frac{66,000}{1 - \frac{3,80,000}{5,00,000}} = \text{Rs. 2,75,000}$$

(b) With increase in variable cost :

Revised variable expenses = Rs. 1,10,000

Revised total variable cost = Rs. 3,90,000

(It is assumed that variable expenses refer only to variable overhead and not the direct materials and direct labour)

$$\text{Revised break-even volume} = \frac{60,000}{1 - \frac{3,90,000}{5,00,000}} = \text{Rs. 2,72,727}$$

(Graph has not been shown)

EXAMPLE 10.12 (Sales expansion programme)

The imports for 1982 of a firm of wine and brandy shippers were as follows :

Description	Quantity (gallons)	Cost per gallon
Wine upto 25° proof spirit	30,000	2
Wine from 26° to 42° proof spirit	20,000	3
Brandy, in cask	40,000	10

The sales value of these imports is £8,25,000. Distribution and bottling costs average £4 per gallon. Management, clerical and selling costs tend to remain fixed in the short-term at £100,000 per annum. Rates, depreciation and cellarage costs amount to £50,000. Additional sales of 20% all round are proposed and these are likely to add £50,000 per annum in respect of advertising, selling and cellarage costs.

Prepare a break-even chart to reflect operations on the existing and proposed scales. Read from the chart :

(a) break-even point before and after sales expansion.

(b) margin of safety before and after sales expansion.

(I.C.M.A., Final)

ANSWER :

The existing and proposed positions are as follows :—

	Present	Proposed (20% additional sales)
	£	£
Sales	825,000	990,000
Variable cost	550,000	660,000
Margin	275,000	330,000
Fixed cost	150,000	200,000
Profit	125,000	130,000
B.E. Point	450,000	600,000
M/S	375,000	390,000

The chart drawn from the above data is given in Fig. 10.17.

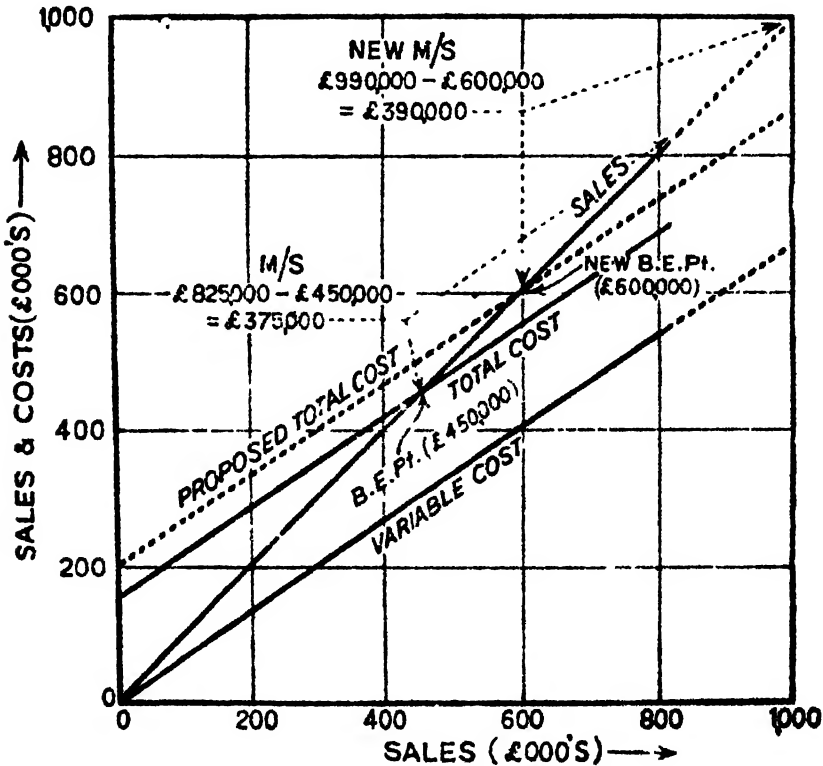


Fig. 10.17. Sales Expansion Programme

EXAMPLE 10.13.

(Effect on profit of increased sales and additional sales at reduced price to maintain profit)

Summarised figures from a manufacturer's budgets are as given overleaf.

	Quantity	Unit price £	Total £
Sales	17,500 units	180	3,150,000
Marginal cost :			
Material		50	875,000
Wages		45	787,500
Variable overhead		36	630,000
		£131	£2,292,500

Assuming that the period costs, which are £500,000 remain unaffected, calculate

- unit margin ,
 - total margin ,
 - profit/volume percentage ;
 - total contribution ,
 - effect on profit of making and selling a further 2,500 units , and
 - additional sales required to produce the same profit with units sales price reduced to £162 each
- (I C M A , Final)

ANSWER :

(a) Unit margin - £180 - £131 = £49

(b) and (d) total margin or total contribution = £3,150,000 - £2,292,500 = £857,500

(c) P/V percentage $\frac{\text{Contribution per unit}}{\text{Sale price per unit}} \times 100$
 $= \frac{£49}{£180} \times 100 = 27.2\%$

(e) Assuming that there is no other varying factor, further sales of 2,500 units will give additional contribution of $2,500 \times 49 = £122,500$

(f) Revised P/V $\frac{£162 - £131}{£162} = \frac{31}{162}$

Revised sales volume $\frac{\text{Fixed cost} + \text{Profit to be maintained}}{\text{Revised P/V}}$
 $\frac{£500,000 + £357,500}{11/162} = £4,481,130$

This is equivalent of $\frac{£4,481,130}{162} = 27,661$ units

∴ Increased sales $27,661 - 17,500 = 10,161$ units

(Existing profit to be maintained is £3,150,000 - (£2,292,500 + £500,000) = £357,500)

EXAMPLE 10 14.

(Increase in capacity accompanied by increase in fixed cost but no increase/decrease in sale price)

A company manufactures a single product which sells at £2.50 per unit. The marginal cost of this product is £1.75 per unit, and at present the fixed expenses of the organisation are £50,000 per annum, with a maximum capacity of 100,000 units per annum.

Capacity can be increased in stages by making changes which will increase the annual fixed expenses of the business, as follows :

- (a) At 100,000 units per annum, the addition of £10,000 per annum fixed charges will increase capacity to 150,000 units per annum ;
- (b) At 150,000 units per annum, the addition of a further £20,000 per annum fixed charges will increase capacity to 200,000 units per annum ;
- (c) At 200,000 units per annum, the addition of yet a further £30,000 per annum fixed

charges will increase capacity to 250,000 units per annum ;

Sales beyond 200,000 units per annum can be achieved only if the selling price of the product is reduced to £2.40 per unit. It is estimated that maximum demand is 250,000 units per annum.

The marginal cost per unit will not be affected at any point in the expansion programme.

Present this information graphically, and make recommendations to management in respect of each addition to capacity. (I.C.M.A., Final)

ANSWER :

The sales line is drawn in two stages, one for £2.50 per unit and the other for £2.40 per unit. The marginal cost line is only one for all capacities. The total cost line is drawn in four stages to account for the changes in fixed cost.

The graph is given below :

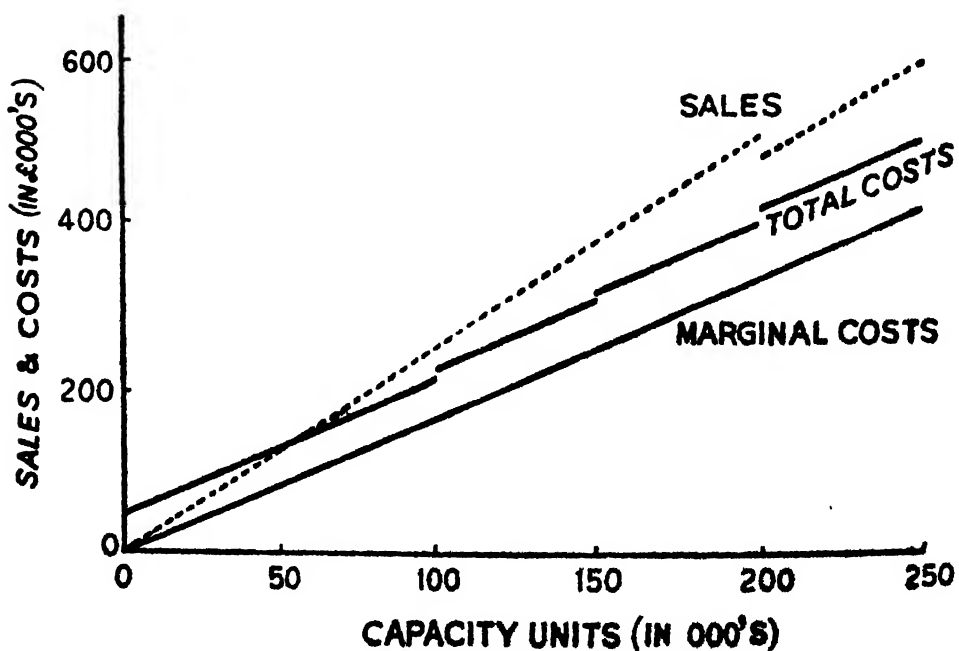


Fig. 10.18

The recommendations are as follows :

- (i) Break-even point = £144,000 of sales (57,600 units × £2.50)
- (ii) Margin of safety is low at the first stage.
- (iii) Profit increases from £30,000 in the first stage to £70,000 in the second stage.
- (iv) In transition from stage 2 to stage 3, profits are less than before until the sales volume reaches 175,000 units.
- (v) At 200,000 units level, the profit may go up to £96,000 but above that capacity, say at 250,000 level the profit is only £90,000. Optimum level is, therefore, 200,000 units.

EXAMPLE 10.15. (*Expansion accompanied with cost reduction*)

A manufacturing company operating in a single region contemplates expanding its activities by stages to cover the whole country. Market research and extensive cost investigation indicate that the following figures will be applicable to the first stage of expansion :

Additional buildings required	..	..	..	£500,000
Additional equipment	..	.	..	£845,000
Additional sales and office	..	..	..	£600,000

Depreciation of buildings (5% per annum) and of equipment (10% per annum) is by the straight-line method. Fixed overhead, other than depreciation, is estimated to increase by £10,500.

Present figures, before the expansion, are summarised as follows :

Fixed overhead annually	..	..	.	£200,000
Materials annually	..	..	..	£200,000
Wages and variable overhead annually			..	£400,000
Annual sales	.	.	.	£900,000

The proposed scale of operations is expected to yield some minor economies in material purchase price for all of the output so that the proposed sales total will be reached if further £120,000 annually is spent on materials. Similarly, other economies will result in a less than proportional increase in the wages and variable overhead, upon which annual outlay will be increased by £90,000.

Present the information represented by the above figures graphically on a single break-even chart. Extract from the chart summarised details of interest to the management.

(I.C.M.A., Pt. IV)

ANSWER :

	Present (£ in thousands)	Proposed (£ in thousands)
Capacity	45%*	75%
Sales	900	1,500
Variable cost	600	810
Fixed cost	200	320
Total cost	800	1,130
*Assumed		

The graph (Fig. 10.19) is drawn with the help of the above data.

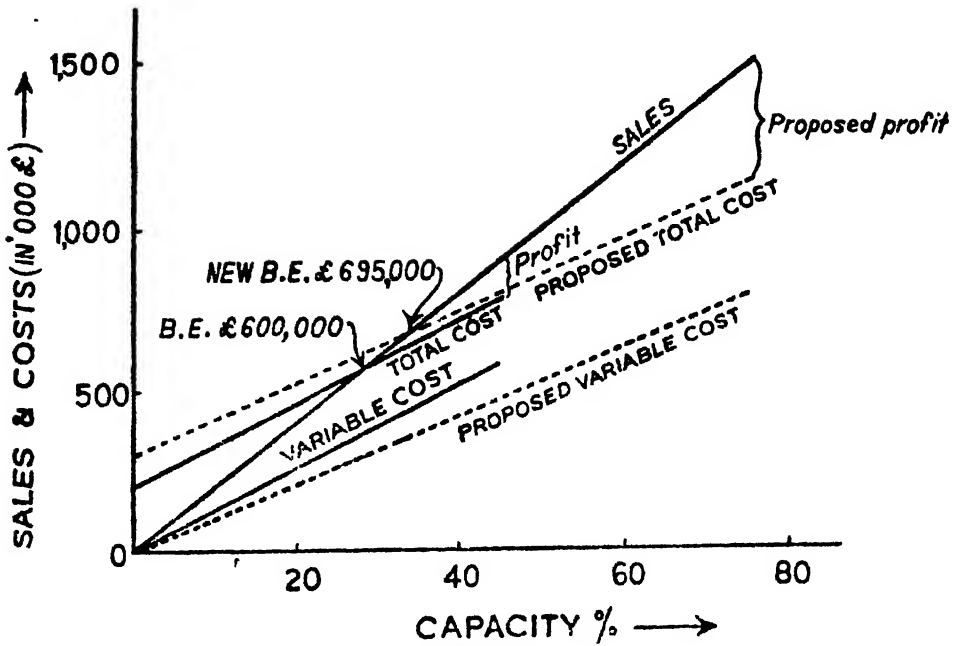


Fig. 10.19.

The following information is obtained from the graph :

	Present	Proposed
B.E. Point	£600,000	£695,000
Margin of safety	£300,000	£805,000
Contribution ratio $\left(\frac{S-V}{S}\right)$	33½%	46%
Profit	£100,000	£370,000
Profit Sales	11.25%	24.6%

EXAMPLE 10.16 (Acceptance of order for which additional cash outlay on fixed cost is necessary)

An engineering shop manufactures in batches to customers' instructions and an order is regarded as profitable only if the contribution to general fixed overheads is equal to the labour cost.

An enquiry is received for the manufacture of certain components which would necessitate the purchase of special jigs and tools at a cost of £250. Costs per component are estimated at :

	£
Direct material	3.125
Direct labour	1.700
Direct expenses	0.250
Variable overheads	1.300

A selling price £8.50 per component is quoted.

From the above data, prepare a chart showing at what sales level contribution towards general fixed overheads will commence, and also the sales level at which the order will be considered profitable.

(I.C.M.A., Final)

ANSWER :

The graph is shown in Fig. 10.20

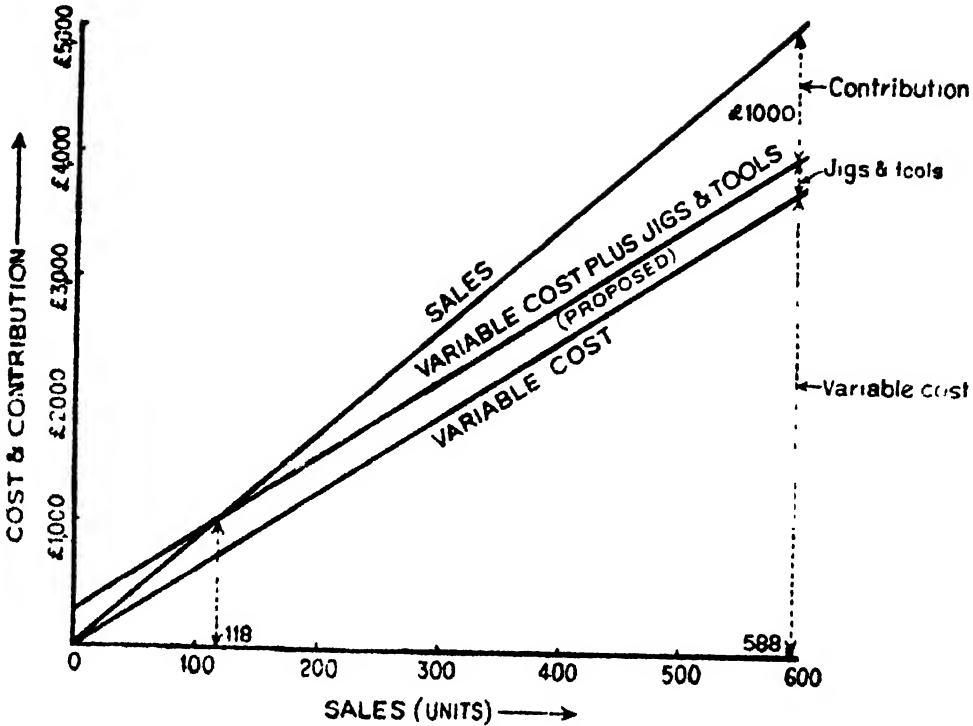


Fig. 10.20.

From the graph, we get the following information :

Contribution starts at the level of 118 units.

Sales level at which order will be profitable (will yield highest margin, viz. £1,000) is 588

units. This may be checked up as follows .

	<i>Per unit</i>	
Sales	£8,500	
Variable cost	£6,375	
	<hr/>	
Contribution	£2,125	
Contribution @ £2.125 for 588 units		£1,250
Less Special jigs		250
		<hr/>
Contribution		£1,000

EXAMPLE 10.17. (Change in product mix)

You are furnished undernoted data :

	<i>Product A</i>	<i>Product B</i>
Sales	10,000 units @ Re. 1	7,500 units @ Rs. 1.33
Costs :		
Fixed	Rs. 2,000	Rs. 5,500
Variable	@ Re. 0.60 per unit	@ Re. 0.40 per unit

Determine the effect on profits, if sales of A or B are increased in the mixture of total sales. Illustrate your argument by graphic representation. (I.C.W.A., Final)

ANSWER :

Existing Mix No. I : 10,000 units of A and 7,500 units of B

Proposed Mix (assumed) : No. II 15,000 units A and 7,500 units B

No. III 10,000 units A and 15,000 units B

The position will be as follows :

Product	Existing Mix I		
	A	B	Total
Sales	Rs. 10,000	Rs. 10,000	Rs. 20,000
Variable cost	Rs. 6,000	Rs. 3,000	Rs. 9,000
Fixed cost	Rs. 2,000	Rs. 5,500	Rs. 7,500
Profit	Rs. 2,000	Rs. 1,500	Rs. 3,500

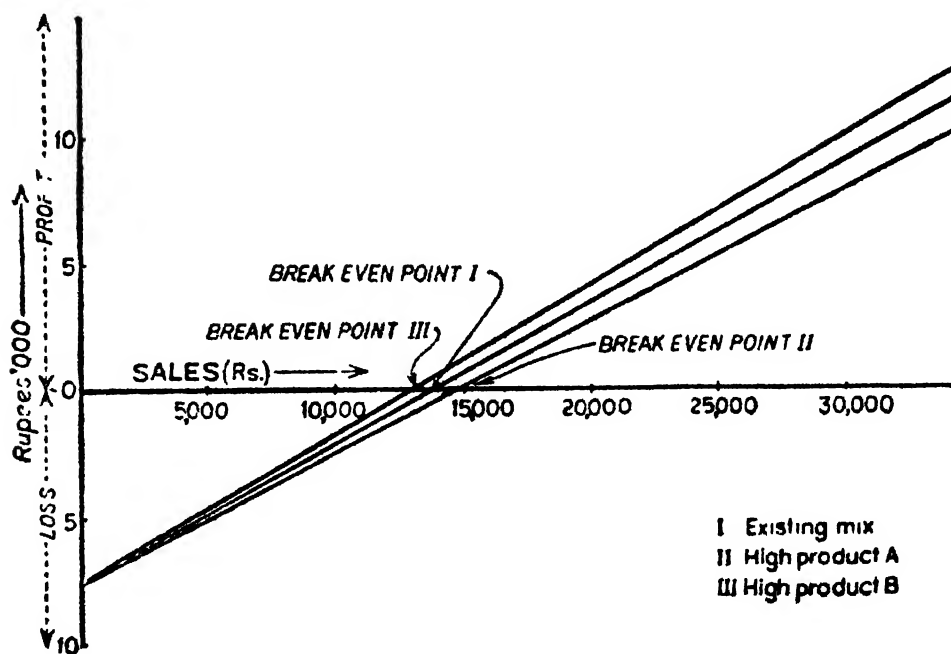


Fig 10.21.

Proposed Mix II (Increase in Product A)

Product	Proposed Mix II (Increase in Product A)		
	A	B	Total
Sales	Rs. 15,000	Rs. 10,000	Rs. 25,000
Variable cost	Rs. 9,000	Rs. 3,000	Rs. 12,000
Fixed cost	Rs. 2,000	Rs. 5,500	Rs. 7,500
Profit	Rs. 4,000	Rs. 1,500	Rs. 5,500

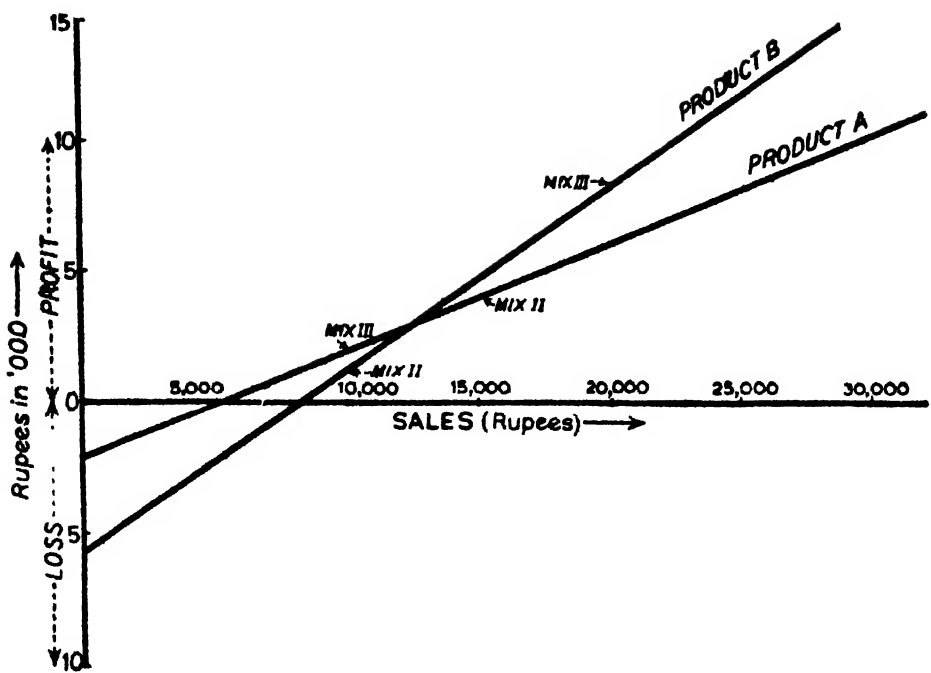


Fig. 10.22

Proposed Mix III (Increase in Product B)

Product	A	B	Total
Sales	Rs. 10,000	Rs. 20,000	Rs. 30,000
Variable cost	Rs. 6,000	Rs. 6,000	Rs. 12,000
Fixed cost	Rs. 2,000	Rs. 5,500	Rs. 7,500
Profit	Rs. 2,000	Rs. 8,500	Rs. 10,500

A profit chart showing the break-even points for each of the three mixes is given in Fig. 10.21. Another chart showing the effect on profit of each of the products in mix II and mix III is given in Fig. 10.22.

EXAMINATION QUESTIONS

1. The following two suggestions are under consideration. :
- (a) Ten per cent reduction in price to yield an increase in sales volumes from 6,600 to 7,900 units.
 - (b) Ten per cent increase in price with decrease in volume of sales from 6,600 to 5,700 units.
- The following particulars are given :
- | | |
|--------------------|----------|
| | Rs. |
| Current unit price | 1,000 |
| Unit variable cost | 500 |
| Fixed cost | 30 lakhs |
- Prepare a statement comparing gross revenue, profit contribution and P/V ratio of the two alternatives with present results. Which suggestion would you recommend ?
(I.C.W.A., Final)

2. "The size of the 'Margin of safety' is an extremely valuable guide to the strength of the business". Discuss what are the possible steps to rectify the position when the 'Margin of safety' is unsatisfactory? *(I.C.W.A., Final)*
3. A company making and marketing a single product contemplates expansion of output. With the existing type of factory equipment the variable cost of £200 per unit of output is practically constant from 1,000 to 8,000 units, but more equipment than at present will be required if output in excess of 3,000 units annually is produced. This extension of equipment would increase total annual fixed costs from £900,000 to £1,200,000.

You are asked to provide the management with a graph from which profit or loss for any level of sales, can be determined. The following figures should be used to plot the sales curve.

<i>Units of output</i>	<i>Selling price per unit (£)</i>
1,500	1,000
2,000	950
2,500	900
3,000	850
4,000	760
5,000	700
6,000	600
7,000	500
8,000	400

Read from the graph the output figure at which the sales curve overtakes total costs, and the output figure at which profit is at its maximum. *(I.C.M.A., Final)*

4. As a newly appointed management accountant in a manufacturing company you have undertaken a survey of the data readily available to you. These include the following figures :

<i>Month</i>	<i>Sales £</i>	<i>Loss/Profit on sales £</i>
January	325,000	Profit 10,000
February	360,000	Profit 15,000
March	380,000	Profit 25,000
April	400,000	Profit 25,000
May	420,000	Profit 40,000
June	470,000	Profit 50,000
July	450,000	Profit 50,000
August	440,000	Profit 50,000
September	315,000	Profit 10,000
October	280,000	Loss 5,000
November	250,000	Loss 10,000
December	230,000	Loss 20,000

Using graphical method, determine the break-even point. What other information may be derived from your graph? *(I.C.M.A., Final)*

5. What conclusions can be drawn from the position of the break-even point and the angle of incidence in a break-even chart?

Sale of product amounts to 200 units per month at Rs. 10 per unit. Fixed overhead is Rs. 400 per month and variable cost Rs. 6 per unit.

There is a proposal to reduce prices by 10 per cent. Calculate present and future P/V ratios and find, by applying P/V ratio, how many units must be sold to maintain total profit. *(I.C.W.A., Final)*

6. (a) What do you understand by the term 'Margin of safety' with reference to a volume of production?
- (b) How do the following reflect on a break-even volume and on a P/V ratio?
 - (i) Increase in total fixed costs.
 - (ii) Increase in physical sales.
 - (iii) Decrease in variable costs per unit.

(I.C.W.A., Inter)

7. (a) Show that $S = \frac{F \times S_1}{S_1 - V_1}$

Where S = Sales at break-even point

F = Total fixed cost

S_1 = Sales at any given level

V_1 = Variable cost (total) at S_1 sales level

- (b) There are two factories under the same management. The management desires to merge these two plants. The following particulars are available:

	Factory I	Factory II
Capacity Operation	100 percent	60 percent
Sales	Rs 300 lakhs	Rs 120 lakhs
Variable Costs	Rs 220 lakhs	Rs 90 lakhs
Fixed Costs	Rs 40 lakhs	Rs 20 lakhs

You are required to calculate (i) What would be the capacity of the Merged Plant to be operated for the purpose of breaking even, and (ii) What would be the profitability on working at 75 per cent of the Merged Capacity. (ICWA, Inter)

8. Any change in fixed costs, variable costs or selling price has the effect of shifting the break-even point although the impact of each such change on the break-even point and the profit is different. Illustrate this with the help of the figures given below assuming a 10% increase individually in each of the three elements stated above. Also show how the profit figure is affected if all the elements increase collectively each by 10%.

Sales (30 000 units)		Rs 1 20 000
Variable Cost	Rs 40 000	
Fixed Cost	Rs 50 000	Rs 60 000
Profit		Rs 30 000

(ICWA, Final)

9. A Company currently operating at 50% capacity has the following profit/loss particulars:

	Rs	Rs
Sales		12 80 000
Costs		
Direct Materials	4 00 000	
Direct Labour	1 60 000	
Variable Overheads	80 000	
Fixed Overheads	5 20 000	11 60 000
		<u>1 20 000</u>

An export order has been received that would utilise half the capacity of the factory. The order has either to be taken in full and executed at 10% below the normal domestic prices, or rejected totally. The alternatives available to the management are given below:

- (1) Reject the order and continue with the domestic sales only, as at present.
- (2) Accept order, split capacity equally between overseas and domestic sales and turn away excess domestic demand.
- (3) Increase capacity so as to accept the export order and maintain the present domestic sales by:
 - (a) buying an equipment that will increase capacity by 10%, and fixed cost by Rs 40,000 and,
 - (b) work overtime at time and a half to meet balance of required capacity.

Prepare comparative statements of profitability and suggest the best alternative.

(ICWA, Final)

10. Allplay Ltd. are specialists in the manufacture of dolls for children. They manufacture and market four types of dolls patented under the names, Dolly, Molly, Jolly, Polly, and a doll/dress sewing kit. They require your assistance as a Cost Accountant for determining the appropriate sales and product-mix of their products for the coming year. From the production standards established, market forecasts and pricing

policies, you get the following data :—

Doll's name	Estimated Demand for next year units	Standard Material cost per unit Rs.	Standard Labour cost per unit Rs.	Established Net price per unit Rs.
Dolly	50,000	1.40	0.80	5.20
Molly	42,000	0.70	0.50	2.40
Jolly	35,000	2.70	1.40	8.50
Polly	40,000	1.00	1.00	4.00
Sewing kit	3,25,000	0.60	0.40	3.00

- (i) To promote sales of the sewing kit, there is a 15% disco offered in the established price of a kit, purchased at the same time along with a doll and it is expected that all customers will avail this benefit.
- (ii) The labour rate of Rs. 2.00 per hour is expected to continue without change in the next year. The plant has an effective capacity of 1,30,000 labour hours on a single shift basis. Present equipment can produce all of the products. Overtime worked is paid at double the normal rate.
- (iii) Next year's fixed cost is estimated as Rs. 30,000 in the factory, Rs. 20,000 in administration and Rs. 50,250 in selling and distribution.
- (iv) Variable costs will be equivalent to 50% of standard direct labour cost.
- (v) The Company has a very small inventory of its products that can be ignored.
 - (a) You are required to draw a conservative estimate for next year of the total contribution that would be made by each product line and the net income that would be earned by the company.
 - (b) The company is at present having some industrial relations problem and if this continues in the next year, it would not then be possible to arrange for overtime work. Anticipating the eventuality, you are required to suggest a product-mix that would absolutely minimize the drop in the income already envisaged.

With that product-mix work out productwise contribution and the new net income that would be earned as a result. (I.C.W.A., Final)

11. (a) Identify and discuss briefly five assumptions underlying cost-volume-profit analysis.
- (b) A local authority, whose area includes a holiday resort situated on the east coast, operates for 30 weeks each year, a holiday home which is let to visiting parties of children in care from other authorities. The children are accompanied by their own house mothers who supervise them throughout their holiday. From 6 to 15 guests are accepted on terms of £100 per person per week. No differential charges exist for adults and children.

Weekly cost incurred by the host authority are

	£ per guest
Food	25
Electricity for heating and cooking	3
Domestic (laundry, cleaning etc.) expenses	5
Use of minibus	10

Seasonal staff supervise and carry out the necessary duties at home at a cost of £11,000 for the 30-week period. This provides staffing sufficient for 6 to 10 guests per week but if 11 or more guests are to be accommodated, additional staff at a total cost of £200 per week are engaged for the whole of the 30-week period.

Rent including rates for the property, is £40,000 per annum and the garden of the home is maintained by the council's recreation department which charges a nominal fee of £1,000 per annum.

You are required to

- (i) tabulate the appropriate figures in such a way as to show the break-even point(s) and to comment on your figure;
- (ii) draw, on the graph paper provided, a chart to illustrate your answer to (b) (i) above.

(I.C.M.A., Stage 2)

CHAPTER 11

BUDGETING AND BUDGETARY CONTROL

Comprehensive budgetary control procedures provide invaluable aid for scientific management. Budgeting provides a powerful tool to the management for the efficient performance of its functions viz. formulating plans, co-ordinating activities, and controlling operations.

Budgets. A budget is a financial and/or quantitative statement, prepared prior to a defined period of time, of the policy to be pursued during that period for the purpose of attaining a given objective. An analysis of this definition will reveal the essential features of a budget, namely that (i) a budget may be expressed in terms of money or quantity, or both, (ii) it should be developed prior to the period during which it is to operate, (iii) it is set for a definite period, and (iv) before its preparation, the objective to be attained and the policy to be pursued to achieve that objective are required to be laid down. Budgeting lays emphasis on the necessity for advance decision on future course of action to be followed and points out the result which would accrue by following that course of action.

The objectives of setting budgets may be summarised as follows :-

- (a) A budget is a blue print of the desired plan of a firm or operation. Plans covering the entire organisation and all its functions like purchase, production, sales, financial management, research and development are expressed through budgets. The budget serves as a declaration of policies and also defines the objective for executives at all levels of management.
- (b) Budgets provide a means of co-ordination of the business as a whole. In the process of establishing budgets, the various factors like production capacity, sales possibilities, and procurement of material, labour, etc. are balanced and co-ordinated so that all the activities proceed according to the objective. Budgets inculcate team spirit and are like putting so many heads together to solve a common problem.
- (c) Budgets are means of communication. Complex plans laid down by the top management are passed on to those who are responsible for putting them into action.
- (d) Budgets facilitate centralised control with delegated authority and responsibility. Grouped according to the responsibilities of different executive levels, they facilitate decentralisation of work. Budgets are instruments of managerial control by means of which the management can measure performances in every part of the concern and take corrective action as soon as any deviations from the budgets come to light.

Budgetary Control. Budgetary control is defined as the establishment of budgets relating the responsibilities of executives to the requirements of a policy and the continuous comparison of actual with budgeted results, either to secure by individual action the objective of that policy or to provide a basis for its revision. It follows that a budgetary control system secures control over performances and related costs in different parts of a business, (i) by establishing budgets, (ii) by comparing actual attainments against the budgets, and (iii) taking corrective action and remedial measures or revision of the budgets, if necessary. The budgets put the plan in a concrete form and the follow-up action to see that the plan is adhered to (i.e. the actuals do not exceed the budgets) completes the system of control. In other words, while budgeting is the art of planning, budgetary control is the act of adhering to the plan.

The *advantages* of a budgetary control system which arise from the achievement of the objectives of budgeting, viz. profit planning and control are as follows :—

- (i) Budgetary control aims at maximisation of profits through effective planning and control of income and expenditure directing capital and resources to the best and most profitable channel.
- (ii) It provides a clear definition of the objective and policies of the concern and a tool for subjecting these policies to periodic examination.
- (iii) There is a planned approach to expenditure and financing of the business so that economy is effected in the utilisation of funds to the optimum benefit of the concern. The benefit is extended to the national economy if all concerns and industries have the budget approach. This provides a basis for stable employment in the country, makes economic use of limited resources of the nation and prevents wastage.
- (iv) The functions and performances of the various branches and spheres of the organisation are closely co-ordinated in a well-knit pattern. This results in closer co-operation between the various members of the organisation.
- (v) Each level of management is aware of its task and the best way by which it is to be performed. This maximises the effective utilisation of men, material and resources.
- (vi) Deviations from budgets point out the weak spots and inefficiencies so that proper remedial measures can be taken. Efforts are concentrated only over a small portion of the expenditure which is not in conformity with the norm, leaving out the bulk which, being within the budget, needs no attention and thus, reports are furnished under the principles of '*management or control by exception*'.
- (vii) As budgets are set for each item of expenditure against departments and against each executive, they provide a motivating force urging all concerned to work efficiently.
- (viii) Budgeting ensures sufficiency of working capital in the business during the budget period.
- (ix) It creates in the management the habit of thinking ahead—making careful study of the problems in advance before taking decisions.

- (x) A budgetary control system assists delegation of authority and is a powerful tool of *responsibility accounting*.
- (xi) It stabilises the conditions in industries which are subject to seasonal or cyclic fluctuations.
- (xii) Budgets are the fore-runners of standard costs in the sense that they create necessary conditions to suit setting up of standard costs.
- (xiii) By providing means for continuous appraisal of departmental performance, a budgetary control system supplies a basis for internal audit.
- (xiv) The method of evaluating performance against budgets provides a suitable basis for establishing incentive systems of remuneration by results.
- (xv) It aids in obtaining bank credit.

Preliminaries for the Adoption of a System of Budgetary Control. For the successful implementation of a system of budgetary control certain pre-requisites are to be fulfilled. These are summarised below :

- (i) There should be an organisation chart laying out in clear terms the responsibilities and duties of each level of executives, and the delegation of authority to the various levels. For complete success, a solid foundation in this regard should be laid at the outset. Attention given to the organisation chart is, therefore, no waste of efforts and would be amply rewarded in the long run.
- (ii) The objectives, plans, and policies of the business should be defined in clear cut and unambiguous terms. The areas to be covered by the budgetary scheme should be clearly laid down.
- (iii) The output level for which budgets are fixed, i.e. the budgeted output, should be stated.
- (iv) The particular budget factor which will be the starting point of the preparation of the various budgets should be indicated.
- (v) There should be an efficient system of accounting to record and provide data in line with the budgetary control system. It is actually the combined efforts of the management and the accountant that make a budgetary control system successful.
- (vi) For the establishment and efficient execution of the plan, a *Budget Committee* should be set up.
- (vii) There should be a proper system of communication and reporting between the various levels of management. This should be a two way system which would enable the top level to communicate the plan to the lower levels in clear terms who in turn should feed-back by reporting on the variances, i.e. deviations from the budgets, to the higher levels. Based on this feed-back, the top level may again communicate instructions lower down for taking corrective action. The Budget Controller being the person who is responsible for co-ordination should be able to sell his ideas to the various levels.
- (viii) There should be a charter of programme. This is usually in the form of a *budget manual* wherein all details regarding the plan and its procedure of operation are given. The manual will also specify the length of the budget period.

- (ix) The budgets should primarily be prepared by those who are responsible for performance.
- (x) The budgets should be complete (i.e. covering all phases), continuous, and realistic (i.e. attainable).
- (xi) There should be an assurance from the top management executives of co-operation and acceptance of the budgetary system. This requirement is so obvious that it is often missed, resulting in failure of the scheme due to disagreements which arise later.

Organisation for Budgetary Control For the success of a system of budgetary control, it is essential that there should be a sound organisation for budget preparation, budget maintenance, and budget administration. Budgetary control is a concerted action in which a number of individuals take part and it is to be ensured that proper link and close co-ordination exist amongst them. When budgets are being set, it is a matter of common prudence that all those who will be responsible for the execution and operation of the budgetary system should be taken into confidence. When this is done, not only will the spheres of respective responsibilities be clearly understood by each individual but a spirit of co-operation and team work will grow up leading to a high degree of budget consciousness.

The budgetary control organisation is usually headed by a top executive who is known variously as the *Budget Controller*, *Budget Director*, or *Budget Officer*. As the Budget Controller is required to command the respect, confidence, and co-operation of all the members of the organisation, he should be well experienced and thoroughly knowledgeable in regard to budget matters, competent and tactful in his work and he should have a sort of persuasive spirit to carry the men with him. In smaller organisations, a top official is made responsible for looking after the budgets over and above his other normal duties in other spheres of the organisation. Big organisations can, however, afford to have a full time Budget Controller and it is always better to have one if possible.

The Budget Controller may have under him a Budget Committee constituted with the representatives of the various departments like purchase, sales, production, research and development, administration, and accounts. The budget committee may be entrusted, in general, with the following duties :—

- (i) To receive, scrutinise, revise (if necessary), and approve budgets prepared by the various functional divisions of the concern.
- (ii) To receive from time to time budget reports comparing actuals with the budgets.
- (iii) To locate responsibilities and suggest corrective action and remedial measures or revision of the budgets, as necessary.
- (iv) To participate in discussions regarding new projects or programmes which have a bearing on the budgets.

The above functions of the Budget Committee evidently form a part of the duties of the Budget Controller. These duties may be summarised as follows :—

- (i) Maintain liaison with the various functional managers and guide them in regard to budget matters. For the exercise of this function, the Budget Controller acts as the Chairman or Secretary of the Budget Committee.

- (ii) Undertake responsibility for review and maintenance of the budget manual and for making amendments thereto, as and when considered necessary.
- (iii) Prepare budget programme and issue instructions in accordance with such a programme.
- (iv) Revise and scrutinize budgets as received from the various functional heads and pass on necessary budgetary information to such departments which are dependent on other budgets for the preparation of their own budgets.
- (v) Discuss with the Budget Committee, proposed requirements of the departments and overall budgets.
- (vi) Prepare summary budgets in consultation with the Budget Committee and again place all budgets and connected information before the Budget Committee.
- (vii) Revise budgets as recommended by the Budget Committee and pass on the final budgets to the Board of Directors for final approval before they are communicated to the departments concerned.
- (viii) Obtain actual costs from the Cost Office, prepare comparative statements of actuals and budgets in the Budget Report, place them before the Budget Committee with reasons for variances and convey decisions taken there on to the respective managers.

Mention may be made of the relationship of the Budget Controller with the Accounts or Cost Accounts Department. The Budget Controller may, according to convenience, be made responsible to the President, Chairman, Chief Executive or the Accounts Chief. If attached to the Chief Accountant, he is able to maintain a close link between the accounting records and the budget—he has a ready and direct access to all accounting information and in fact, he himself compiles the accounting data as is needed for the functioning of the budgets, obviating any overlapping of work.

Behavioural Aspects of Budgetary Control. A budgetary control system (and so also a system of standard costs) is not entirely mechanistic so as to operate automatically once it is set in motion but it requires the co-ordinated efforts and involvement of a number of persons belonging to the various sectors of the concern. As such, the success of such a system will largely depend upon the quality and ability of the individuals who operate the system. Unless the men are properly motivated towards adhering to the budgets and standards and achieving the sub-objectives and the over-all objective of the organisation, no budgetary system will work howsoever nicely it may be designed. In the budgeting procedure we have to deal with human beings and their behaviours and it is essential that while designing and operating a budgetary control system, the behavioural aspects should be given their due consideration. The behavioural factors which should specifically be looked into in this regard are as follows :

- (i) Those who would be made responsible to achieve the budget should be fully associated with the process of setting the budgets and no budgets should be imposed from the top. Such participation by the lower levels would act as a forceful motivating factor towards achieving the budget targets.

- (ii) The personnel involved in the operation of the system should be suitably trained and educated so that they are able to appreciate their roles not only in keeping their own budgets but in achieving the corporate objective.
- (iii) Individuals should be made responsible only for the costs they can control.
- (iv) While real favourable variances are always to be commended, adverse variances should not invariably be viewed as failures of the individuals concerned but as stepping stones towards future successes.

Budget Manual. As stated earlier, one of the duties of the Budget Controller is to maintain the budget manual. A budget manual lays down the details of the organisational set up, the routine procedure and programme to be followed for developing budgets for the various items, and the duties and responsibilities of the executives including the Budget Committee and the Budget Director/Controller regarding the operation of the budgetary control system. The manual is a document which sets out, *inter alia*, the responsibilities of the persons connected with the budgets and the forms and records required for budgetary control. The contents of a budget manual may be summarised as follows :—

- (i) Enunciation of principles and objectives.
- (ii) Responsibilities and duties of each department/individual of the organisation with relation to the budgetary system.
- (iii) Functions and duties of the Budget Committee and Budget Controller.
- (iv) Scope of the budget and the areas to be covered, e.g. whether fixed or flexible budget will be set
- (v) Dates of receipt of forecast statements from the various departments.
- (vi) Length of the budget period and the time of revision of budgets.
- (vii) Methods of preparation and detailed steps to be taken for setting the various budgets.
- (viii) Methods of accounting and control of expenditure.
- (ix) Procedure for preparation of financial statements and for reporting.
- (x) Budget diagrams.

The *advantages* of a budget manual, which in fact are the advantages of most other types of manual, are as follows :—

- (i) Everyone concerned with the budgets is given to understand precisely in writing, what is his role in the system, what is to be done and how it is to be done.
- (ii) As the procedures and instructions are put down in writing in the manual, ambiguity is avoided, reliance on memory is eliminated, and period of training during which staff may become familiar with the procedure is reduced.
- (iii) All methods and procedures are standardised.
- (iv) As the authority and responsibility of each individual is properly defined, the risk of overlapping of functions is eliminated.

Forecasts and Budgets. The nature of forecasts and budgets is, to some extent, similar in as much as both are related to actions and events during a

stipulated future period. There is, however, a wide difference between the two as indicated below :

- (i) Forecasts are mere estimates of what is likely to happen. They are statements of probable events, i.e. events which are likely to take place under anticipated conditions during a certain specified period. Budgets relate to planned events, i.e. the policy or programme to be followed in the future under prescribed conditions.
- (ii) While forecasts are events over which no control can be exercised, budgeting connotes a sense of control, i.e. an action which can be shaped according to will to suit conditions which may or may not happen. For example, the sales manager of a business may, with his intimate knowledge of the conditions prevailing in the market, forecast a specific quantity of a product which he will be able to sell during the period. Keeping this forecast in view and depending upon the production capacity of the business, the sales budget may be set at a figure which may be different from the forecast sales.
- (iii) The function of forecasting ends with the assessment of the probable event. Budgetary control is preceded by forecasting—forecasts are converted into budgets and the control function starts with the setting of the approved budget.
- (iv) Forecasts are also made for purposes other than budgeting, e.g. where several alternative courses of action are possible, forecasts of the anticipated results from each may be made before a decision is taken for adopting the best course. Economic forecasts of general business conditions may also have nothing to do with budgeting.

Length of the Budget Period. A budget period is the length of time for which a budget is prepared and remains operative. No definite indication can be given as to what should be the period for which the budgets for a particular industry or business will be established. This would vary from industry to industry and even within the same industry or business, the length of the budget period may be different for different functions or departments. For example, capital expenditure budgets may be developed for long periods of three to five or even ten years but the other budgets like sales and production budgets may be fixed for shorter periods.

The budget period depends upon the following :

- (i) The type of budget, i.e. sales, production, capital expenditure, cash etc.
- (ii) General economic situation and the growth and stability of the product market.
- (iii) Nature of demand for the products of the undertaking.
- (iv) Length of the trade cycle of the business (length of cycle in the case of seasonal product).
- (v) Production cycle, i.e. the start to finish period required for manufacture of the various products.
- (vi) Timing of the availability of finances.
- (vii) Extent of control required over the operations.
- (viii) Probability of changes in products or product mix.

Industries incurring very heavy capital expenditure such as those engaged in shipping, transport, and power generation may have long-term budgets for a period as long as ten years. Concerns manufacturing motor vehicles, radios, refrigerators and such other products the models or designs of which are changed frequently, may have budgets established for one to three years. In seasonal industries or in industries like clothing and shoe manufacturing where fashions change very often, budgets for six monthly periods may be developed. Most of the industries, however, fix annual budgets as it is much more convenient to have a budget period which synchronises with the financial accounting year of the enterprise.

A long-term budget has the following *advantages* :—

- (i) Purchase of materials may be made on long-term basis so that price advantages may be obtained.
- (ii) Long production runs reduce setting up time and result in higher productivity of men and machines due to specialisations of labour, plants and machinery.

Long-term budgets need not be set very accurately and they may not be completely integrated, i.e. long-term budgets need be prepared only for selected sectors of the business such as for capital expenditure, research and development, long-term finances, etc. Long-term budgets are, therefore, not very useful from the control point of view. For control purposes, budgets for monthly periods are more convenient although in some cases, weekly budgets may also be required.

As a compromise, the usual practice is to have two types of budgets, viz. a long-term budget for planning and a short-term budget for control. These two types of budgets are known respectively as the basic budget and the current budget.

Basic budget is a budget which is established for use unaltered over a long period of time. This is generally used for capital expenditure, research and development, acquisition of capital funds, etc.

Current budget is a budget which is established for use over a short period of time and is related to current conditions.

A system of *continuous budgeting* or *rolling budget* is in use by many concerns. In this system, the budgets are reviewed and updated at regular intervals, say monthly or quarterly, and in the light of experience gained, new targets are set and opportunity is taken to revise the budget figures for the twelve months immediately ahead. Thus at every updating, the month (or quarter) already passed is omitted and the twelfth month (or the fresh quarter) is added to make up a complete year. The main advantage is that the budgets so revised from time to time are more realistic and variances from budgets are reduced.

Scope of the Budgeting Plan and Kinds of Budgets. Budgets may be prepared for as small or as large a portion of the business as is necessary. They may cover only a few functions or may be intended for all functions and all types of expenditure. In large organisations, it becomes difficult to communicate policy decisions emanating from top levels to the executives responsible for operating those policies. In such conditions, the need for budgetary control is felt

all the more in order to make up for the lack of communication. It is, however, not the intention to stress here that it is only the bigger concerns which have the need for budgeting. A system of budgetary control is equally important and fruitful in a small concern.

Depending upon the requirements of the concern and the purpose which a budget is to serve, budgets are classified into several types or groups. Some of these are :

Responsibility budget : Budgets are set for operation by a department or by an executive responsible for it. The stress, therefore, is on the control aspect of budgeting.

Programme budget : Separate budgets are set for each plan or programme of action of the concern. This enables the management to assess the economics of the various programmes.

Operating budget : The operating budget shows planned operations for the forthcoming period and includes the sales, production, production cost, and selling and distribution expenses budgets.

Functional budget : This refers to the budgets set for each function of the business, such as sales, production, research, purchase, finance, etc.

Financial budget : This includes the cash budget showing the anticipated sources and utilisation of cash, budgeted Balance Sheet, and budgeted Profit and Loss Account.

Capital budget : The capital budget relates to capital expenditure. It assesses the economics of capital expenditure and investment.

Performance budget : The performance budget is established in such a manner as to plan and control the performance of individual sectors, areas and functions of management.

Development of Budgets. The development or setting of the individual budgets starts after deciding upon matters like the scope of the budgets and the areas to be covered by them, appointment of a budget officer and the budget committee, and the suitable time to start a budgeting scheme. In developing budgets, past figures form the basis upon which the budget structure is built. Nevertheless budgets are not mere extrapolations of the historical data. Being the end product of a mixture of good and unsatisfactory performances in the past, historical data are not correct guides for planning future performance. For the purpose of budgeting, the unsatisfactory performances should, therefore, be weeded out from the past data and the good performances suitably modified to fit in with the anticipated changes in future conditions, i.e. the events likely to happen. The plan of a comprehensive budgetary control system is shown in Fig. 11.1. The plan is illustrative only since there is considerable diversity of practice in this regard and the scope and details of the budget plans vary widely from one business to another.

The preliminary budgets for each function and for each section of the business are prepared by the budget officer in collaboration with the individuals responsible for controlling the actual results of the particular functions and sections. When these preliminary budgets (which are mainly in the nature of

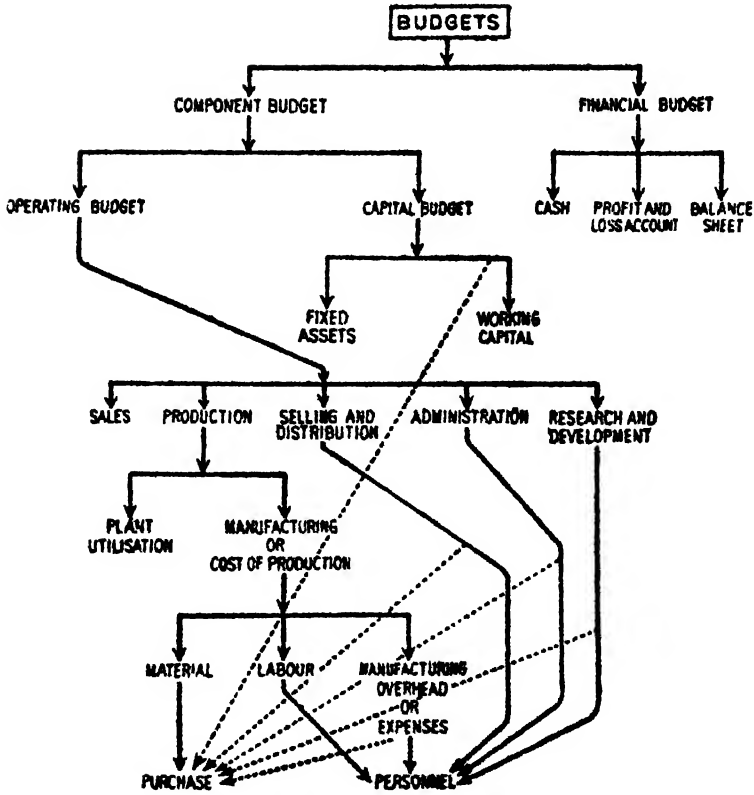


Fig. 11.1. Budget Plan

forecasts) are ready, the budget committee meets to co-ordinate them and to formulate the final budgets. Before its emergence in the final integrated form, each individual budget is thoroughly scrutinized, discussed and modified, as necessary, in the light of its relationship with the other budgets.

Principal Budget Factor. Budgets embrace all functions and cover all the sectors of a business organisation. For the successful implementation of a budgetary system, the individual budgets for each item should be co-ordinated and inter-related. Because of this interlink, the limitation or constraint affecting a particular budget has its influence on the rest of the budgets. A factor which is of such an importance that it affects almost all the other functional budgets to a large extent, is known as the Principal Budget Factor. Principal budget factor is the factor the extent of the influence of which must first be assessed in order to ensure that the functional budgets are reasonably capable of fulfilment. A principal budget factor may be a shortage of orders, or non-availability or shortage of raw materials, skilled labour, working capital, or plant capacity, or Government restrictions. If for example, the production manager in a concern budgets for 1,000 units to be produced per day but the sales manager is able to budget for sales of only 800 units per day, due to lack of customers' demand, the limiting factor of low demand would constitute the principal budget factor. In this case, the sales budget has to be set first, and all other budgets would be

subordinate to it. The principal budget factor constitutes the starting point for the preparation of the various budgets. The main factor is known as the principal budget factor or *Key factor* and the other minor factors may be termed *limiting factors* or *governing factors*.

Consideration of the principal budget factor is also important from another view point. The factor highlights the limitations within which the undertaking functions. For example, when sales limitation is a factor, it points to the necessity for sales promotion or some other action to improve sales. On the other hand, if sales could be increased but for a limitation in production, the situation calls for action to improve the productive capacity. It would also be seen that the principal budget factor is not fixed for all times and it changes according as one or the other factor becomes a limiting factor.

Sales Budget. The first step in the preparation of the sales budget is to forecast as accurately as possible, the sales anticipated during the budget period. Sales forecasts are usually prepared by the sales manager assisted by the market research personnel. Sales forecasts are influenced by a large number of factors, external as well as internal :

External factors : General business conditions, Government policy, cycle of national economy, purchasing capacity of customers, change in buying habits, etc.

Internal factors : Profit desired, sales trend, sales prices, new products, seasonal products, etc.

Nevertheless, correct forecasting of sales is essential as the entire basis of profit planning rests on this forecast.

Sales forecast may be prepared by one or more of the methods discussed below. As no one method gives satisfactory results, usually several methods are adopted simultaneously. A procedure commonly adopted is to prepare first, a preliminary forecast for the various product lines based on past statistical data. The preliminary forecast is then modified in the light of reports received from salesmen, and finally adjusted on the basis of external trade considerations and other factors, stated above.

- (i) *Market research :* This is a specialised field, detailed discussion of which is beyond the scope of this book. Briefly, the purpose of market research is to evaluate customer motivation. Market research tries to find out which of the company's product can be sold in a period and in what quantities, at what price, and in which market. Such an analysis can be made to assess the potential demands according to customers, territories (or geographical regions), salesmen, channels of distribution, size of orders, or terms of sales. Another function of market research is to ascertain the causes leading to the limitation of the sales of a product and to find means for increasing sales. Market research relies upon behavioural sciences, like sociology, psychology, etc. and for the purpose of collecting data, it applies methods which include consulting trade journals and other publications, carrying out surveys of markets, and interviewing customers.

- (ii) *Analysis of past sales figures* : This and the methods described in the following sub-sections actually form a part of market research. This analysis is meant to prepare a sort of 'desk forecast' from the sales figures of the previous years and this may be applied where a refined technique of market research may not have been developed. One simple method is to prepare a scattergraph with the help of sales levels data for a number of past periods; the expected sales in the next period, i.e. the budget period can be obtained by a projection of the line of best fit. Such a scattergraph is shown in Fig. 11.2.

Sophisticated statistical methods of analysis to past sales data may also be applied for revealing trends, trade cycles, seasonal movements, etc. so that more realistic assessment of potential demands may be made.

- (iii) *Assessment and report by salesmen* : Being in the field and in close contact with the market and the customer, the salesmen, sales managers and sales agents can, with their experience, forecast sales realistically. Asking salesmen to furnish estimates stimulates their interest and co-operation in budgeting but care should be taken while accepting these estimates as sometimes, biased figures may be furnished. Such data furnished by the salesmen may be mere guesses, based on personal judgement which may tend to be over-optimistic.

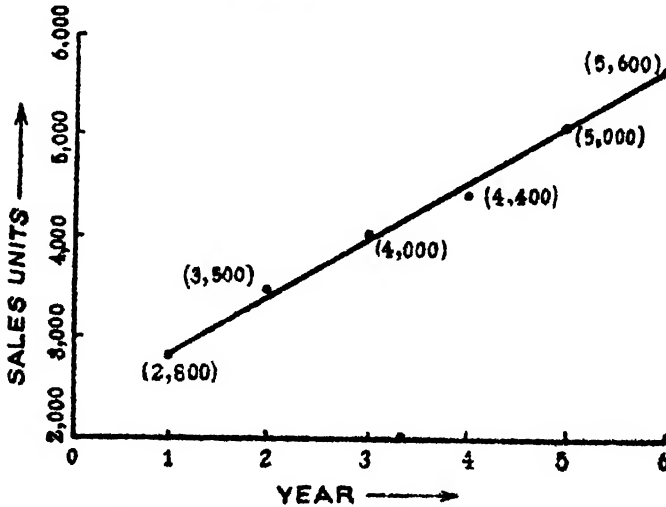


Fig. 11.2. Scattergraph of projected sales volume

It will be seen from the diagram that the forecast sales for the 6th year will be 5,600 units, i.e. the point where the line of best fit crosses a line drawn perpendicular to the 6th year's mark on the horizontal axis.

- (iv) *Study of general trade and business situation* : General trade and prevailing business conditions affect sales. Competition from other industries, position of supply of material and labour, availability of supplies of bought-out finished goods for resale, and trade conditions in the industries which are the main customers for the concern's product, should be kept in view.

- (v) *Other miscellaneous considerations*, e.g. advertising and sales promotion, product profitability, production capacity, long-term sales trends of the various products, restrictions imposed by the Government etc. should also be kept in view. The cost accountant also scrutinizes the sales forecast with a view to analysing the relationship between costs and selling prices at various levels and arriving at the optimum profit forecast.

Sales forecasts indicate the quantity of anticipated sales of the various products at different estimated price levels. The total profit as well as the profit contribution of individual products which each of the forecast sales when materialized is likely to yield are computed. Limiting factors such as shortage of raw material, skilled labour, machine capacity, or working capital, if any, are taken into consideration and the profit contribution per unit of the limiting factor is projected. The best forecast sales mix that would give maximum profit is then decided upon.

The accepted sales forecast is then converted into the sales budget. The sales forecast is based upon certain assumptions regarding the enterprise objective (say, expected profit), level of advertisement, sales promotion and other selling efforts, etc. which are related to the levels existing in the immediate past. Sales budget, however, carries an imprint of management judgement and strategy and takes into account the planned management objective and strategy and the future

SALES BUDGET
By Product and Time
For the year ending 31st December, 19..

Period	Product A		Product B		Product C		Total Amount
	Units	Amount Rs. 30 per unit	Units	Amount Rs. 40 per unit	Units	Amount Rs. 20 per unit	
January	4,000	1,20,000	5,000	2,00,000	10,000	2,00,000	5,20,000
February	4,500	1,35,000	6,000	2,40,000	8,000	1,60,000	5,35,000
March	5,000	1,50,000	5,000	2,00,000	7,000	1,40,000	4,90,000
Total 1st Quarter	13,500	4,05,000	16,000	6,40,000	25,000	5,00,000	15,45,000
2nd Quarter	12,000	3,60,000	18,000	7,20,000	30,000	6,00,000	16,80,000
3rd Quarter	16,000	4,80,000	20,000	8,00,000	32,000	6,40,000	19,20,000
4th Quarter	15,000	4,50,000	16,000	6,40,000	28,000	5,60,000	16,50,000
Total for the year	56,500	16,95,000	70,000	28,00,000	1,15,000	23,00,000	67,95,000

Fig. 11.3. Sales Budget

commitments. In practice, the forecast is co-ordinated and synchronised with similar forecasts for production and other functions of the business. If the sales forecast gives the desired profit by utilizing the existing capacity, it may be adopted as the sales budget without any change. If, however, the sales forecast is higher than past sales and if it creates a capital investment problem, the forecast figures may be accepted as budgets only if the investment is justifiable and funds are available. If the forecast is lower than the past sales but the top management insists on the achievement of increased profits, this would call for measures like sales price increases, sales promotion and reduction in variable and fixed costs for attaining the profit objective.

The format of a sales budget classified according to products may be seen in Fig. 11.3. Sales budgets may also be prepared according to products, areas, territories, types of customers, salesmen, or sales agents. Some manufactured products have a seasonal sales pattern so that sales are not uniform throughout the budget period. In such cases, the budget should not be based on the average sales for the budget period but seasonal or operating sales budgets for smaller periods should be set.

Production Budget. The production budget is a forecast of the production for the budget period. Production budget is prepared in two parts, viz. production volume budget for the physical units of the products to be manufactured and the cost of production or manufacturing budget detailing the budgeted cost under material, labour, and factory overhead in respect of the products. The following steps are involved in the preparation of the production budget :—

- (i) *Production planning* : Production planning plays a very important part in the establishment of the production budget in physical units. Production planning on sound lines takes into consideration optimum utilization of plant capacity by elimination or reduction of limiting factors and bottlenecks in production like shortage of material, labour, capital etc. Proper planning of production levels out seasonal fluctuations of sales so that optimum inventory of finished products, components, and work-in-progress is maintained. While production planning in a concern manufacturing standard products is easier, it is possible in the case of production to order also, to suitably plan and budget the production of some standard parts or components.
- (ii) *Consideration of capacity* : The total quantity of each of the products or group of products which the concern is capable of producing is determined. For this purpose, co-ordination with the plant utilization budget will be necessary. The level of attainment to be adopted for budgeting should be based on normal capacity likely to be achieved ; it should not be either too high or too low.
- (iii) *Integration with the sales forecast budget* : This is necessary for avoiding imbalance of sales and production. It may so happen that the entire production of the concern is not capable of being sold. If the position cannot be improved, the production budget should be pruned so as to fall in line with the sales budget. If on the other hand, selling is not a problem, the quantity as fixed at (i) above, may be taken as the optimum for budget purposes. If expected sales exceed the existing capacity, attempts should be made to balance production with sales forecast by resorting to overtime or additional shift work, or to consider on a long-term basis, the need for an expansion programme.
- (iv) *Determination of quantity to be held in stock* : The extent to which inventory of finished goods is to be carried, depends upon several factors such as future sales potential, availability of storage facilities, the risk and cost of stock-out and cost of carrying inventory. The budgeted quantity of production is arrived at by adding to the budgeted sales quantity, the difference between the opening and closing inventories of the finished goods. The inventory of work-in-progress in the pipeline

should also be taken into consideration if a significant change between the opening and closing inventories of work-in-progress is anticipated. The difference between the equivalent units in the opening and closing inventories will, in such case, be the additional units for manufacture to be included in the production budget.

PRODUCTION BUDGET								
Year :			Product :			Department :		
Month	Units required for sales	Add Closing Stock of Finished Goods	Total required	Less Opening Stock of Finished Goods	Production units to be completed	Add Equivalent units in Closing w-in-p	Less Equivalent units in Opening w-in-p	Total Equivalent units to be completed
Jan								
Feb								
Mar								
Apr								
May								
Jun								
Jul								
Aug								
Sep								
Oct								
Nov								
Dec								
Total								

Fig. 11.4. Production Budget

(v) *Policy of the management* : Sometimes, policy decisions are to be taken before finally setting the budget. For example, it may have to be considered whether certain components or parts should be manufactured or purchased.

A format of production budget suitable for showing the budgeted units for a product for various periods of manufacture is illustrated in Fig. 11.4. Production budgets may also be classified by each department of manufacture.

The following *advantages* result from the operation of a production budget :—

- (i) Best utilization of the productive resources of the business.
- (ii) Assistance in computation of forecast profit and loss statement provides a means of evaluating performance and profitability.
- (iii) Maintenance of low inventory which obviates risk of obsolescence and fall in price.
- (iv) Production of goods according to schedule which enables delivery dates to be kept.
- (v) Reduction in costs as a result of uniformity in production.

- (vi) Assistance in setting the purchase budget enabling purchases to be made at economic prices.
- (vii) Scheduling requirements of labour.

Plant Utilisation Budget. The plant capacity required to carry out the production programme as per the production budget is laid down in the plant utilisation budget. In fact, this budget is prepared almost simultaneously with the production budget after synchronising the plant capacity with the production units as per the production budget and the sales forecast. The budgeted capacity is set in terms of convenient physical units, such as weight or number of products, or working hours. The plant utilisation budget determines the machine load in each department during the budget period so that overloading may be corrected or action taken to utilise surplus capacity. Bottlenecks created by over-loading may be removed by working overtime, off-loading (i.e. transfer of work to other departments where surplus capacity is available), procurement or expansion of plants, or passing on the excess work to sub-contractors. On the other hand, idle facility may be utilised by making efforts to increase demand for the products.

An illustration of machine utilization budget is given in the example below :

EXAMPLE 11.1.

Three articles X, Y and Z are produced in a factory. They pass through two cost centres A and B. From the data furnished compile a statement for budgeted machine utilisation in both the centres.

(a) *Sales Budget for the year*

Product	Annual Budgeted Sales (units)	Opening Stock of Finished Product (units)	Closing Stock
X	4,800	600	Equivalent to 2 months' sales
Y	2,400	300	"
Z	2,400	800	"

(b) *Machine Hours per unit of Products*

Product	Machine hours per unit	
	Cost Centres	
	A	B
X	30	70
Y	200	100
Z	30	20

(c) *Total number of Machines :*

Cost Centre	
A	284
B	256
Total	540

(d) *Total working hours during the year ; Estimated 2,500 hours per Machine.*

(I.C.W.A., Inter)

ANSWER :

First the, Production Budget is prepared as follows :—

Production Budget for the year . . .				
Product	Sales	Closing stock	Opening stock	Production Budget
	(1)	(2)	(3)	(1)+(2)–(3)
	(units)	(units)	(units)	(units)
X	4,800	800	600	5,000
Y	2,400	400	300	2,500
Z	2,400	400	800	2,000

The machine utilization budget will be constructed as follows :—

Machine Utilization Budget for the year . . .				
Cost Centre A				Cost Centre B
Product	Units	Hours per unit	Total machine hours	No. of machines required
X	5,000	30	1,50,000	60
Y	2,500	200	5,00,000	200
Z	2,000	30	60,000	24
			7,10,000	284
			(284 × 2,500)	
				6,40,000
				(256 × 2,500)

Cost of Production (or Manufacturing Cost) Budget. Cost of production budget (also known as manufacturing budget) is a forecast of the cost of the production which has been planned in the production budget. The physical units in the production budget are broken into the elements, i.e. material quantity and labour time, and the estimated costs of materials, labour, and manufacturing overhead are computed. Cost of production budget consists of the three subsidiary budgets, viz. materials, labour and expenses (or manufacturing overhead) budgets. A specimen form of cost of production budget prepared according to products may be seen in Fig. 11.5. This may also be arranged and analysed departmentwise so that responsibility can be correctly fixed on the individuals who control the expenditure of a department.

Materials Budget. The material budget includes quantities of direct materials ; the quantities of each raw material needed for each finished product in the budget period is specified. The input data for this budget is obtained by applying standard material usage rates by each type of material to the volume of output budgeted.

The materials budget serves the following purposes :—

- (i) It assists the purchase department in suitably planning the purchases so that materials are delivered when needed and provides data for determining the cash requirements for raw materials purchase.
- (ii) It enables establishment of purchase cost budget.
- (iii) It helps the fixation of maximum and minimum levels of materials, components, etc. for effective planning.
- (iv) It provides data for calculation of raw material cost of manufacture product wise.
- (v) It assists in control of raw material usage.

PRODUCTION COST BUDGET												
Period												
Product	Machine or Department	Materials				Labour					Factory overhead	
		Items of materials	Quantity required for total production	Rate per unit	Cost	Operation	Trade and grade	Hours	Hourly rate	Cost	Department	Cost
A		1				1					X	
		2				2					Y	
		3										
		4										
B		1				1					Z	
		2				2						
						3						
C		1				1					X	
		2									Y	
		3									Z	

Fig. 11.5. Production Cost Budget

In the preparation of material budget, the material requirement in terms of quantity for each product or each cost centre is determined. The quantities of the various materials including bought out components required for production during the budget period, are indicated in this budget. Only direct materials are included ; indirect materials are generally included in the manufacturing overhead budget. Due allowance is made for material spoilage likely to occur in course of manufacture. For inclusion in the purchase budget, the budgeted cost of materials is computed by aggregating the value (total quantity multiplied by estimated unit price) of each material. Where standard costing system is in use, the standard material costs per unit of product multiplied by the total units of product in the production budget would give the budgeted cost of materials. Where standard costing system is not in use, the relevant figures may be obtained from estimates or from past actuals suitably modified to the conditions anticipated during the budget period.

Purchase Budget. The purchase budget establishes the quantity and value of the various items of materials to be purchased for delivery at specified points

of time during the budget period taking into account the production schedule of the concern and the inventory requirements. It takes into account the requirements for the entire budget plan as per the sales, materials (or manufacturing overhead for indirect materials), maintenance, research and development, and capital budgets. Purchases may be required to be made in respect of direct and indirect materials, finished goods for resale, components and parts, and purchased services. Before incorporation in the purchase budget, these purchase requirements should be suitably adjusted to account for the following :—

- (i) Orders for purchases already placed ;
- (ii) Materials already booked or earmarked for incomplete orders ;
- (iii) The planned closing stock of the material less the opening stock ;
- (iv) Stocks required to be built up for future requirements, sudden shortage, etc. ;
- (v) Storage space ;
- (vi) Economic size of order ;
- (vii) Price considerations ;
- (viii) Availability of finance ;
- (ix) Policy of the management regarding purchase of those materials which can as well be manufactured.

Purchase budgets are essential as they (i) enable the purchase department to plan its normal purchases efficiently and also to make economical purchases in advance in order to take advantage of long-term contracts, (ii) serve as a guide for timely provision of funds for purchasing, and (iii) provide the material prices on which the budget plan is based.

An illustration showing the preparation of production, materials and purchase budgets is given below :

EXAMPLE 11.2.

ABC Limited manufactures three products from three basic raw materials in three departments. The company operates a budgetary control system and values its stock of finished goods on a marginal cost basis. From the data given below, you are required to produce for the month of June 1979 the following budgets :

- (a) production ;
- (b) materials usage ;
- (c) purchase ;
- (d) profit and loss account for each product and in total.

Budgeted data for June 1979 :

Product :	A	B	C
Sales	£1,500,000	£1,080,000	£1,680,000
Stock of finished products at 1st June 1979, in units	3,000	2,000	2,500
Department :	I	II	III
Fixed production overhead	£239,000	£201,300	£391,200
Direct labour hours	47,800	67,100	65,200
Direct material :	DM11	DM21	DM31
Stock at 1st June 1979, in units	24,500	20,500	17,500

The company is introducing a new system of inventory control which should reduce stocks. The forecast is that stocks at 30th June 1979 will be reduced as follows : raw materials by 10% and finished products by 20%.

Fixed production overhead is absorbed on a direct labour hour basis. It is expected that there will be no work-in-progress at the beginning or end of the month.

Administration cost is absorbed by products at a rate of 20% of production cost and selling and distribution cost is absorbed by products at a rate of 40% of production cost.

Profit is budgeted as a percentage of total cost as follows : product *A* 25%; product *B* 12½%; and product *C* 16½%.

Standard cost data, per unit of product :

Product :	Price per unit £	<i>A</i> units	<i>B</i> units	<i>C</i> units
Direct material :				
DM 11	2.00	5	—	12
DM 21	4.00	—	10	9
DM 31	1.00	5	5	—
	Rate per hour £	hours	hours	hours
Direct wages :				
Department : I	2.50	4	2	2
II	2.00	6	2	3
III	1.50	2	4	6
		£	£	£
Other variable costs		10	20	15

(I.C.M.A., Pt 1)

ANSWER :

From the data given, the sale quantities for the month are arrived at as follows :

	Products		
	<i>A</i> £ per unit	<i>B</i> £ per unit	<i>C</i> £ per unit
Direct material : DM 11	10	—	24
DM 21	—	40	36
DM 31	5	5	—
	15	45	60
Direct wages : Dept. I	10	5	5
Dept. II	12	4	6
Dept. III	3	6	9
	25	15	20
Other variable costs	10	20	15
	35	35	35
Total variable costs	50	80	95
Fixed production overhead :			
Dept. I (£239,000/47,800) £5	20	10	10
Dept. II (£201,300/67,100) £3	18	6	9
Dept. III (£391,200/65,200) £6	12	24	36
	50	40	55
Production cost	100	120	150
Administration cost @ 20%	20	24	30
Selling and distribution cost @ 40%	40	48	60
	160	192	240
Total cost	160	192	240
Profit (<i>A</i> 25%; <i>B</i> 12½%; <i>C</i> 16½%)	40	24	40
	200	216	280
Selling prices	200	216	280
Sales quantities :			
<i>A</i> £1,500,000/200	7,500		
<i>B</i> £1,080,000/216		5,000	
<i>C</i> £1,680,000/280			6,000

(a) Production Budget

	<i>A</i>	<i>B</i>	<i>C</i>
Sales quantities	7,500	5,000	6,000
Add closing stock	2,400	1,600	2,000
Less opening stock	3,000	2,000	2,500
Production quantities	6,900	4,600	5,500

(b) Materials Usage Budget

	DM 11	DM 21	DM 31
Product <i>A</i> (6,900 × 5 ; 6,900 × 5)	34,500	—	34,500
<i>B</i> (4,600 × 10 ; 4,600 × 5)	—	46,000	23,000
<i>C</i> (5,500 × 12 ; 5,500 × 9)	66,000	49,500	—
Total units	100,500	95,500	57,500

(c) Purchase Budget

	DM 11	DM 21	DM 31
Materials	100,500	95,500	57,500
Add closing stock	22,050	18,450	15,750
Less opening stock	24,500	20,500	17,500
Purchase (units)	98,050	93,450	55,750
Price per unit	£2	£4	£1
Purchase (value)	£196,100	£373,800	£55,750

**(d) Profit and Loss Budget
(Marginal cost basis)**

	<i>Products</i>			<i>Total</i>
	<i>A</i>	<i>B</i>	<i>C</i>	
	£	£	£	£
Sales	1,500,000	1,080,000	1,680,000	4,260,000
Less Marginal cost of sales	375,000	400,000	570,000	1,345,000
Marginal contribution	1,125,000	680,000	1,110,000	2,915,000
Fixed costs :				
Production (£239,000 + £201,300 + £391,200)				831,500
Administration				450,000
Selling and distribution				900,000
				2,181,500
Profit				£733,500

Direct Labour (or Labour Cost) Budget. This budget comprises the estimates of direct labour requirements necessary to produce the types and quantities of output planned in the production budget. The direct labour budget should be developed in terms of both direct labour hours and direct labour costs. The labour content of each item of production as per the production budget is first determined in terms of grades and trades of the workers required and the labour time for each job operation, process, product, etc. is determined by time and motion study or otherwise. The rates of pay, allowances, bonus, etc. of each category are then considered and labour cost to be set for each budget centre is calculated by multiplying the wages rate with the labour hours of the number of units of products budgeted. If the workers are placed on an incentive scheme, the labour rates should be suitably increased on an estimated basis to cover the payment of the incentive element. Where standard costing system is in use, the labour cost budget is set by multiplying the standard labour cost per unit to the quantity of anticipated production as per the production budget. In the absence of standard

costs, the information may be obtained from estimated costs or from past records, which may be suitably modified to meet future needs, and included in this budget or in the manufacturing overhead budget. The purpose of direct labour budget are, besides providing planning data in respect to the amount of direct labour required, the number of employees needed (to be included in personnel budget), unit cost of manufacturing each product, determining cash flow requirements and establishing cost control.

Personnel Budget. The personnel budget incorporates the requirements of personnel to carry out the budget plan as laid down in the sales, manufacturing (labour and manufacturing overhead), maintenance, research and development and capital expenditure budgets. The labour requirement is indicated in terms of rupee value, number of labour hours, number and grade of workers, or any other convenient unit. Provision should be made in this budget for shift and overtime work and for the effect of training plans for new workers on labour cost.

The *objectives* of the personnel budget are as follows :—

- (i) Efficient personnel management ;
- (ii) Provision of a suitable yardstick against which the actual labour force may be compared and controlled ;
- (iii) Bringing down labour turnover to the minimum by removing as far as possible the causes leading to high turnover ;
- (iv) Measurement and stabilisation of the ratio between direct labour and indirect labour ;
- (v) Facilitating the preparation of cash budgets in so far as requirements of wages are concerned.

Expenses (or Manufacturing Overhead) Budget. Budgeting of manufacturing overhead is essential for maintaining realistic expense levels required for supporting the budgeted programme and objectives of the enterprise. The preliminaries necessary for the establishment of the budget are stated below. Ordinarily these preliminaries would already be completed while laying down a procedure for the accounting and control of overhead expenses.

- (i) Classification of expenditure into fixed, variable and semi-variable and collection thereof in accordance with a schedule of standing order numbers.
- (ii) Departmentalisation of expenditure. (This is essential because control is exercised over individual departments which incur expenditure.)
- (iii) Deciding upon a volume of production with which the budgets will be linked up. In certain cases, however, the volume of production is not quite relevant. The maintenance department may, for instance, carry out expensive capital work (unrelated to production activities) which is transferred from the production budget to the capital expenditure budget.

The cost accountant prepares the expense budget on the basis of the data available in the manufacturing overhead ledger. In some concerns, the head of the department or the shop is asked to prepare estimates for the expenditure relating to his department. A satisfactory method is to combine the two procedures : the estimates prepared by the cost accountant are reviewed and agreed to by the shop executive and finally approved by the Budget Committee after co-ordination with all the other budgets. The overhead expenses against each Standing Order Number for each department, corresponding to the budgeted

production volume, are estimated. Past actuals for other expenses are suitably modified in accordance with the production programme for the current budget period. The expenditure is initially compiled in terms of quantities, e.g. physical units for materials, labour hours for wages, etc. and then converted into rupee value by applying the budgeted price of materials and the budgeted rates of wages. The total of these estimated expenses, separately for fixed and variable and for each department, constitutes the expense budget for the department.

Fixed (or Static) and Flexible Budgets. A budget may be established, either as a fixed budget or a flexible budget. A *fixed budget (or static budget)* is one which is designed for a specific planned output level and is not adjusted to the level of activity attained at the time of comparison between the budgeted and actual costs. Since this budget relates to only one level of activity planned, it is also known as plan budget. Obviously, a fixed budget is established only for a small period of time when the actual output is not anticipated to differ much from the budgeted output.

It, however, does not mean that the fixed budget is a rigid one, not to be changed at all. Though not adjusted to the actual volume attained, a fixed budget is liable to revision if due to business conditions undergoing a basic change or due to other reasons, actual operations differ widely from those planned in the fixed budget.

Fixed budgets are most suited for fixed expenses. In case of discretionary costs situations where the expenditure is optional and has no relation with the output, e.g. expenditure on research and development, advertising, management consultancy, certain types of repairs and maintenance, employee recreation and some fringe benefits, charitable donations etc., the fixed budget takes the form of the *appropriation type or lump-sum type* of budget. A fixed amount is set as the appropriation to cover the expenditure of the budget centre. In other cases, although many of the items of expenditure may vary with the output, the fixed budget ignores this factor; a particular level of activity is anticipated and all expenses are budgeted for that level.

A fixed budget has only a limited application and is ineffective as a tool for cost control. While comparing the actual cost with a fixed budget, the difference cannot be properly explained and it is not possible to say whether the entire variance was due to change in the level of activity or whether any other factor such as the performance of the operating manager was responsible for it, unless a further detailed analysis is made to find out the real cause for the variance. Fixed budgets are useful where the plan permits maximum stabilization of production, as for example, for organisations which manufacture to build up inventories of finished products and components. Where it is possible to estimate the activities of a business fairly accurately so that there is no significant variation between the planned output and the actual output, fixed budget may be quite satisfactory.

Flexible budget (also known as *control budget* or *variable* or *sliding scale budget*) is a budget which is designed to change appropriately with fluctuations in output or turnover and to furnish budgeted costs for any level of activity actually attained. Flexible budget may also be used for adjusting budgets to current conditions arising out of seasonal variations or changes in the length of the working

period. A flexible budget is more elastic, useful, and practical. It takes into account the changes in the actual circumstances and is useful for the purpose of performance evaluation and control since it segregates the activity factor which is beyond the control of the operating manager and highlights those costs for which he is responsible.

In order to prepare a flexible budget, items of anticipated expenditure are first, classified into fixed, variable, and semi-variable. Budget allowance, i.e. the amount of cost which a budget centre is expected to incur during a specified period of time, in relation to the level or activity attained by the budget centre, is set for each item of expenditure. The allowances in respect of items of fixed costs will be the same for all levels of activity within a given range. Costs which are incurred purely at the discretion of the management do not directly vary with variations in activity and hence these may be excluded in flexible budgeting. In the case of variable costs, activities which cause costs to fluctuate differ from item to item. While direct material and direct labour costs are usually related to the level of production, some of the items of variable overhead costs are related to other activity bases such as labour hours, machine hours, size of order etc. and in certain cases they are related more to fluctuations in input rather than the output. For example, material handling labour cost fluctuates with the quantity of materials handled and not as much with the level of output, and employees training cost has causal relationship with the number of new employees and not with the volume of production. Each item of variable overhead cost should, therefore, be analysed in detail and budget allowances set for a range of anticipated levels of activity. As regards the semi-variable costs, each item is examined and resolved into its fixed and variable elements and a budget is set for different levels on merit depending upon the nature and behaviour of each item. A table (see Fig. 11.6) is prepared showing the budgeted amount for each item of expense against the various levels. It may be noted that some accountants prefer to omit from the flexible budget those items which remain constant at different levels of activity.

It will thus be seen that flexible budget is actually a series of budgets one fixed for each level of activity. The allowance for an actual level of activity which does not correspond to any level in the table may be computed by interpolation, small differences in activity levels being ignored. For example, if budgets have been set for 90% and 100% activities, the budget allowance for 95% activity should be computed by interpolation but if the actual activity is 91% or 92%, the allowance for 90% budgeted activity may be assumed to be fairly correct for the actual activity.

Another method of presenting flexible budgets is to prepare budgets for only one level of activity and express each item of expenditure as a budget formula per unit, i.e. a ratio or rate per unit of the activity base. The allowance for an item of expenditure at any desired level of activity can be computed by means of simple multiplication.

Obviously, this will be possible in cases of setting flexible budgets for only such costs that vary directly with the activity base. Budgets for items of a semi variable or semi-fixed nature will still have to be established individually.

In this method, which reduces the cost of preparation of an elaborate flexible budget, the budget for the actual level of activity is usually prepared at the end of the budget period when actual results are being analysed. However when alternative activity levels are being considered at the planning stage itself, the previous method, i.e. setting up the flexible budget at various activity levels is suitable.

FLEXIBLE BUDGET						
Budget Period		Department				
Operating level :						
Direct labour hours		7 000	8,000	9,000	10,000	11,000
Percentage of capacity		70	80	90	100	110
Standing Order No	Expense	Budget allowance per month				
		Rs.	Rs	Rs	Rs	Rs
01	Indirect labour	850	900	940	980	1,000
22	Shop clerks	150	160	170	170	180
28	Sundry supplies	290	300	315	330	340
32	Overtime premium	—	—	450	500	550
33	Night shift premium	—	—	—	50	50
41	Supervision	1 200	1,200	1,200	1,200	1,200
	Total Controllable	2,490	2,560	3,075	3 230	3,320
61	Power	1,300	1,425	1,500	1,600	1,725
62	Maintenance	1,300	1,400	1,500	1,600	1,700
66	Space cost	850	860	880	890	900
68	General expenses	650	675	700	725	750
	Total Service costs (Controllable)	4,100	4,360	4,580	4,815	5,075
88	Depreciation	600	600	600	600	600
89	Rates and taxes	50	50	50	50	50
90	Insurance	100	100	100	100	100
	Total Non-controllable	750	750	750	750	750
	Total Expenses	7,340	7,670	8,405	8,795	9,145
	Overhead rate per direct labour hour	Rs. 1.049	Re. 0.959	Re. 0.934	Re. 0.879	Re 0.831

Fig. 11.6. Flexible budget for Manufacturing Overhead

Note : Flexible budget for cost of production may be prepared in a similar manner by including direct material and direct labour costs at the various operating levels. A suitable form of a flexible budget for administration, selling and distribution costs may be seen in Fig. 11.8.

The third method is to present the flexible budget in the form of a graph (see Fig. 11.7). A curve representing the budgets against various levels of output may be drawn. Budgeted expenditure may be shown in the graph for each item of expenditure, for each department, or for the business as a whole.

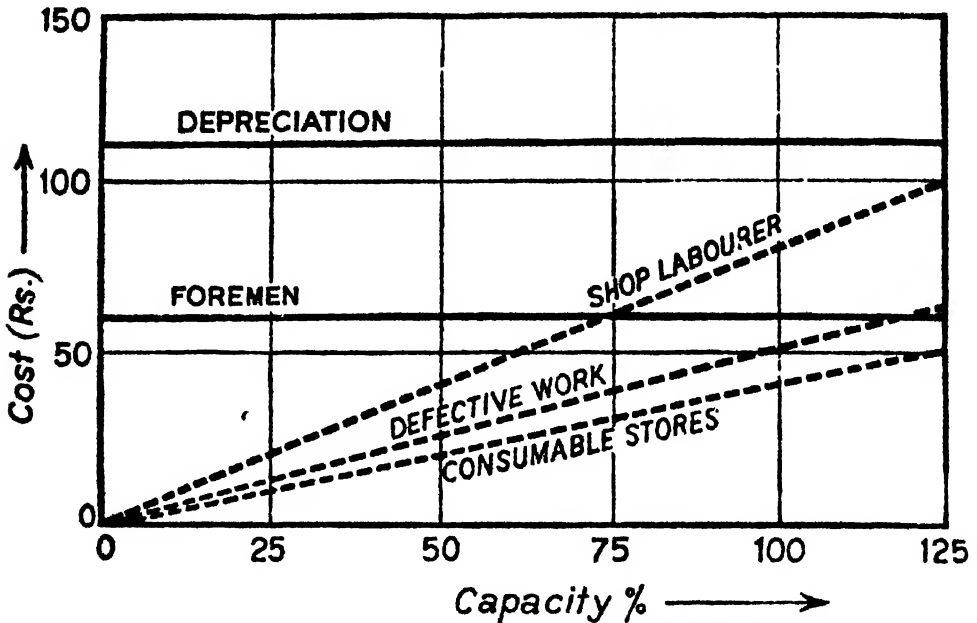


Fig. 11.7. Flexible Budget for Fixed and Variable Expenses

An example illustrating the manner of establishment of flexible budgets is given below :

EXAMPLE 11.3.

The following data are available in a manufacturing company for a yearly period .

Rs. (laks)

Fixed expenses

Wages and salaries	9.5
Rent, rates and taxes	6.6
Depreciation	7.4
Sundry administrative expenses	6.5

Semi-Variable expenses

(at 50% of capacity)

Maintenance and repairs	3.5
Indirect labour	7.9
Sales department salaries etc.	3.8
Sundry administrative expenses	2.8

Variable expenses

(at 50% of capacity)

Materials	21.7
Labour	20.4
Other expenses	7.9
	<hr/>
	98.0

Assume that the fixed expenses remain constant for all levels of production, semi-variable expenses remain constant between 45% and 65% of capacity, increasing by 10% between 65% and 80% capacity and by 20% between 80% and 100% capacity.

Sales at various levels are :

	Rs. (laks)		Rs. (laks)
50% capacity	100	90% capacity	180
60% "	120	100% "	200
75% "	150		

Prepare flexible budget for the year and forecast the profits at 60%, 75%, 90% and 100% of capacity. (I.C.W.A., Inter)

ANSWER .

FLEXIBLE BUDGET

	Capacity					Period
	50%	60%	75%	90%	100%	
	Rs. (laks)	Rs. (laks)	Rs. (laks)	Rs. (laks)	Rs. (laks)	
Sales	100	120	150	180	200	
<i>Variable expenses</i>						
Materials	21.70	26.04	32.55	39.06	43.40	
Labour	20.40	24.48	30.60	36.72	40.80	
Others expenses	7.90	9.48	11.85	14.22	15.80	
<i>Semi-variable expenses</i>						
Maintenance and repairs	3.50	3.50	3.85	4.20	4.20	
Indirect labour	7.90	7.90	8.69	9.48	9.48	
Sales department salaries etc.	3.80	3.80	4.18	4.56	4.56	
Sundry administrative expenses	2.80	2.80	3.08	3.36	3.36	
<i>Fixed expenses</i>						
Wages and salaries	9.50	9.50	9.50	9.50	9.50	
Rent, rates and taxes	6.60	6.60	6.60	6.60	6.60	
Depreciation	7.40	7.40	7.40	7.40	7.40	
Sundry administrative expenses	6.50	6.50	6.50	6.50	6.50	
Total	Rs. 98.00	Rs. 108.00	Rs. 124.80	Rs. 141.60	Rs. 151.60	

It is often argued that the flexible budgetary control approach has become out-dated for the purpose of cost control in production department. The main reason is that production costs are more or less becoming fixed policy costs which are non-controllable by the departmental foremen. The price of materials is largely beyond the control of the foremen, wage structures can hardly be changed (if at all, such changes would be upwards only), labour force cannot be reduced with decrease in capacity utilization and many variable and semivariable expenses are sluggish in their behaviour with change in production levels.

Selling and Distribution Costs Budget. The selling and distribution costs budget which is closely related to the sales budget is the forecast of the cost of selling and distributing, for the budget period. All expenses relating to selling and

distribution of the products referred to in the sales budget are included in the selling and distribution costs budget. Budgets are prepared for each item of selling and distribution overhead based on the volume of sales set in the sales budget. Certain long-term expenses such as advertisement costs are spread over more than one budget period. Selling and distribution expenses may be fixed or variable with regard to the volume of sales ; separate budgets are usually established for fixed or variable selling and distribution expenses in the same manner as fixed and flexible budgets are set up for manufacturing overhead. An illustration of a flexible budget for selling and distribution costs is shown in Fig. 11.8. Budget for administration costs (discussed later in this chapter) has also been shown in the illustration.

Sales volume (Rs) Percentage of capacity				7,00,000 70%	8,00,000 80%	9,00,000 90%	10,00,000 100%	11,00,000 110%
Administration	Cost Account No.	Expenses	% of Sales	Budget allowance per month				
				Rs	Rs.	Rs	Rs	Rs
	01	Office salaries	Fixed	15,000	15,000	15,000	15,000	15,000
	05	General expenses	2%	14,000	16,000	18,000	20,000	22,000
	08	Depreciation	Fixed	6,000	6,000	6,000	6,000	6,000
Selling	11	Rates & Taxes	Fixed	3,000	3,000	3,000	3,000	3,300
		Total Adminis- tration costs	Rs.	38,000	40,000	42,000	44,000	46,000
	52	Salaries	3%	21,000	24,000	27,000	30,000	33,000
	53	Travelling	1%	7,000	8,000	9,000	10,000	11,000
	54	Sales office	0.5%	3,500	4,000	4,500	5,000	5,500
Distribution	60	Advertisement	1%	7,000	8,000	9,000	10,000	11,000
	65	General expenses	1%	7,000	8,000	9,000	10,000	11,000
		Total Selling costs	Rs.	45,500	52,000	58,500	65,000	71,500
	101	Wages	0.5%	3,500	4,000	4,500	5,000	5,500
	102	Rent	1%	7,000	8,000	9,000	10,000	11,000
Total	108	Depreciation	Fixed	8,000	8,000	8,000	8,000	8,000
	110	Maintenance of vehicles	2%	14,000	16,000	18,000	20,000	22,000
	115	Other expenses	0.5%	3,500	4,000	4,500	5,000	5,500
		Total Distribution costs	Rs.	36,000	40,000	44,000	48,000	52,000

Fig. 11.8. Administration, Selling and Distribution Costs Budget

Certain items of selling and distribution costs, e.g. such portions of the cost of the transport department which are related to selling and distribution functions are not included in the selling and distribution costs budget as they may be controlled more effectively by inclusion in the departmental production cost budget. In budget summaries, however, the cost is transferred to the selling and distribution budget.

Fixed Costs Budget. In some concerns, fixed cost budgets are set separately and not included in the functional budgets. This is because fixed costs cannot be controlled by the departmental executive and inclusion of fixed costs in the functional budgets of a department, therefore, serves no purpose. Budget for each item of fixed expenditure is established separately under the main heads, viz. manufacturing, administration, and selling and distribution.

MAINTENANCE COSTS BUDGET	
Period of budget.....	
<i>Preventive Maintenance</i>	Rs.
Labour	
Fitters	
Mistries	
Electricians	
General shop labour	
Stores and supplies	
<i>Repairs</i>	
Labour	
Fitters	
Mistries	
Electricians	
General shop labour	
Stores and supplies	
<i>General maintenance Department</i>	
General shop labour	
Depreciation	
Rent	
Power	
Lighting	
General expenses	
Total	Rs.

Fig. 11.9. Maintenance Costs Budget

Maintenance Costs Budget. Maintenance costs are not directly related to the level of activity of a concern. On the contrary, it is during lean periods of production that maintenance work is undertaken on a larger scale. The nature of repairs and maintenance work is such that it renders the control of these costs difficult. Some of the problems involved in the budgeting of maintenance costs are as follows :—

- (i) The frequency and extent of repair jobs cannot be easily forecast with the result that quantum of costs cannot be estimated in advance.
- (ii) While the maintenance engineer is responsible for input control, the production foreman is responsible for the quantum of maintenance work ; this makes responsibility fixation vague.
- (iii) Maintenance costs being mainly in the nature of semi-variable costs segregation of the variable and fixed elements is essential.

Before setting budgets for maintenance costs, it is necessary to have an overall maintenance schedule showing forecasts of breakdown maintenance, preventive maintenance, emergency repairs, unscheduled repairs etc. Maintenance

costs budget may be set in three parts, viz. for the cost of preventive maintenance, for emergency repairs, and for the costs relating to the maintenance department. Budgets for preventive maintenance are comparatively easier to establish because such maintenance would be pre-planned ; the material and supplies required for maintenance work are determined and the time for each standard operation fixed wherever feasible after proper work study. Standard material and labour costs may thereafter be budgeted. Budgeting for emergency repairs is slightly difficult as no standard for such work can be fixed. Past figures, suitably modified in the light of current and anticipated conditions may be adopted for this purpose. The general costs of the maintenance department such as depreciation, rent and lighting would be usually of a fixed nature and, therefore, may be easily budgeted. A specimen maintenance costs budget is given in Fig. 11.9.

Maintenance costs budgets may be set for the factory as a whole or separately for each operational department which utilizes the services of the Maintenance Department so that each department may control its own expenditure on maintenance. The latter procedure is preferable as it is the departmental foreman and not the maintenance foreman who is in a better position to control the expenditure on maintenance incurred by him. In any case, it is better to introduce the concept of dual responsibility so that though there may be a clear cut demarcation of the responsibilities of the maintenance and production departments, both would be jointly responsible for the control of costs.

Administration Costs Budget. Administration costs budget includes expenditure on the top level management and certain other functions like general office, accounting, finance, legal, etc. An important prerequisite for setting budgets for administration costs is to classify the expenses correctly. This is essential because there are certain items of expenses which may be classified both as production and administration costs. Next, steps should be taken to place every item of expenditure under the control of one or the other executive who would be responsible for its incidence. Most of the items of administration overhead such as salaries of managers, accountants, secretaries, and other staff being of a fixed nature, there is not much difficulty in establishing budgets for these items. Budgets should be set for each item based mainly on past actuals. Historical records should be analysed and adjusted for anticipated changes in general economic conditions and in management policy.

The methods of fixing standards for controlling individual items of administration overhead were considered in Chapter 5. These standards may be taken as guides for establishing budgets for variable administration expenses. Expenses of a semi-variable nature should be split up into the fixed and variable elements. A flexible budget for administration costs has been illustrated in Fig. 11.8.

Advertising Costs (Promotional costs) Budget. The effect of advertising and sales promotion programme is to increase and maintain sales. The advertising costs budget should, therefore, be co-ordinated with the sales budget so that the latter may take into account the likely increased demand as a result of advertising. The best method to establish budgets for advertising costs would be to relate the expenditure to the incremental return, i.e. to the extra income obtained as a result of the advertisement. This is not possible in most cases as the measurement of

effectiveness of advertising cost presents considerable difficulty. This is due to the following :—

- (a) There is a time lag between placement of the advertisement and obtaining the results therefrom.
- (b) Increased sales may not be due to advertising alone. Other factors like improved selling methods, increased buying power of the customers, reduced competition, etc. may also have a favourable impact on sales.
- (c) Changing economic conditions affect advertising costs and the effectiveness of advertising.
- (d) Advertising may not always increase the demand but may merely shift the timing of sales.

For these reasons, advertising and sales promotion expenses are budgeted as definite appropriations for specific periods of time.

As a first step in the budgeting of advertising costs, the best method of advertisement, i.e. the method which is expected to maximise sales should be selected. The next stage is to fix the budget appropriation, i.e. the amount which should be spent on advertising, in the budget period. This may be done by one of the methods discussed below :

- (i) *Percentage of sales* : In this method, the amount of expenditure on advertising is based on a predetermined percentage of expected sales during the budget period. The percentage, which may also be related to the expected profits, is fixed with reference to past records for a number of years. However, historical data may not be suitable in changed current conditions ; these should be adjusted to changes anticipated in the current budget period.

The method is not very sound as effectiveness of advertisement varies for each product, at different sales volume, in different markets, and with differing conditions of competition.

- (ii) *Funds available* : The appropriation of funds for advertising is based on the amount which the company can afford and spare for the purpose. This method is arbitrary and illogical as the amount depends upon what the concern is able to spend on advertisement and it totally ignores the relationship between the advertising cost and the benefit derived from it. In times of depressed sales when the need for advertisement is more pressing, very little money will be allotted for it.
- (iii) *Intensity of competition* : The amount is based on what the competitors in the industry are spending on advertisement. The method is defective because it is difficult to ascertain what others are spending on advertisement. Even if the amount is readily known, it may not be appropriate or suited to the particular situation in the company. The method assumes that the competitors are getting the best results from the spending and that their selling problems are the same as that of the company. These may not always be true.
- (iv) *Task method* : Certain objectives to be achieved by advertising are established and appropriation for advertising expenses made to the extent necessary to meet the objectives.

Research and Development Costs Budget. Like all other budgets, research and development budget provides an effective tool for planning and balancing

the research and development programme. The budget co-ordinates the cost of the programme with the other plans and projects of the company and also provides a means to the management for scrutinising in advance the important aspects of the programme and its problems involved. Research and development costs are considered from both the long and short-term points of view ; the former is to ensure that the business conditions are in keeping with future market demand, and latter is to see that expenditure is incurred on those research and development programmes which give a fair return on the investment. However, the effectiveness of most research and development schemes is not measurable with a reasonable degree of accuracy. The difficulty in planning research and development costs arises due to the following factors :—

- (i) The nature of work pertaining to research and development is different from that relating to the manufacturing function. The scope of research is wide ; it is independent of the time factor and it may not at times produce any result. Development work, however, is more definite in scope and time and hence, planning is relatively easier.
- (ii) Research workers are, in general, less cost conscious and are, therefore, not susceptible to strict control. Development workers have a tendency to prolong the development work till perfection is reached, quite oblivious of the fact that meanwhile, costs may be piling up.
- (iii) Unlike production efforts which yield quicker results, research and development work may extend over several years before it bears fruit.

The following *steps* are involved in the budgetary control of research and development costs :—

Step 1. A clear definition of the objectives of research and development is laid down in the form of a programme. The objective may, for instance, be to reduce costs or provide better service to the consumer.

Step 2. Areas or sectors of responsibility are determined and responsibilities are suitably assigned.

Step 3. Budgeting : Budgets are established for each research and development project on a long-term basis, even for 8 to 10 years, which are further broken up into short-term budgets on annual basis. The budgets are in the form of limits of expenditure set for each project, department, or centre. If the limit is set very high, it would mean waste of resources creating financial difficulties or only a partial utilisation of the funds provided. On the other hand, too little an amount set aside for essential research and development may result in loss of business because of the inability of the concern to withstand competition. A compromise is, therefore, found between the two extremes and an optimum limit is set, based on considerations like general economic conditions, state of competition, demand for the products, and the policy to be adopted.

The *limits* may be fixed under one of the following methods :—

- (a) *As a percentage of sales :* This is an equitable method based on the assumption that more the sales the larger should be the funds provided for research and development. The budgeted sales or the sales for the last year may be used for the purpose.
- (b) *As a percentage of profit :* In this method ; the profit for the last year or the budgeted profit for the current year may be adopted. The drawback

of this method is that when profits are low, the amount provided is reduced though the need for research and development for improving the company's position would then be pressing.

- (c) *Amount based on the ability of the concern to spend* : The amount set apart for research and development depends upon how much the cash position of the concern would permit. Evidently, the amount provided would differ from year to year and if cash resources are diverted to meet urgent and sudden needs elsewhere, very little will be spared for research and development.
- (d) *Amount based on past spending* : The past actuals are taken as the basis for providing funds for the current period. This method is most suitable if future conditions are anticipated and provision is made in accordance with those conditions.

For development expenditure, the budget should be built up to include materials (quantity and costs), manpower needs and labour costs, direct expenses, overhead cost, sub-contract work and capital expenditure necessary

Step 4. Project appraisal and authorisation : After fixation of the budgets and before a project is taken in hand, the Research Manager or Director fixes priorities for the various projects and submits research project authorisation forms seeking approval for each research and development project. The procedure is similar to the one adopted for authorising capital expenditure projects. The authorisation forms, accompanied with project evaluation reports, are put up to the Budget Committee or such other committee specifically drawn for this purpose, which checks the proposed expenditure with particular reference to its timing and adjusts the cash and other budgets accordingly. The projects are finally approved by the appropriate authority who is usually an executive at a senior level.

Evaluation of research and development projects is a difficult problem, albeit a very important one. All proposed projects should be evaluated in financial terms in order to assess their profitability, i.e. to determine whether a project is expected to pay for itself. The expenditure on research and development should be matched against the value of the sales and the profits likely to accrue from the new or additional products and the anticipated saving in cost. The return on capital employed for the project provides an effective yard-stick for measuring the profitability of a project. For the purpose of evaluation, the cost and revenue should be taken at their present worth, worked out under the discounted cash flow method, particularly when alternative projects are being considered. This may not, however, be necessary when the profitability of individual projects is being assessed, in which case, the estimated cost and revenue data may be taken without any adjustment.

Another method of assessing the profitability of research and development projects takes the help of ratios. Some of the common ratios for this purpose relate research and development costs to sales, total costs, capital employed and profit. Standard ratios based on anticipated performances are established ; and actual ratios are then compared with the standards and the variances suitably analysed.

Step 5. Performance evaluation and project re-appraisal : After a project has been sanctioned, work starts in accordance with a phased programme. Expenditure against each research and development project is accumulated in the manner

already discussed previously. A close watch is kept on the expenditure so that it is not allowed to exceed budget provisions. The extent of physical progress made is also periodically assessed to see that it is commensurate with the expenditure incurred. Periodical reports showing financial results are submitted to the various levels such as the Board, R & D Director and R & D Manager in the usual manner keeping in view the general principles of a reporting system.

If the expenditure on a project which is still in progress exceeds or is likely to exceed the budget allotment, a review and re-appraisal of the project is called for. This is comparable with the re-appraisal of capital expenditure projects (see Page 828). The re-appraisal will reveal the loop holes and shortfalls, if any, and also whether the project, if proceeded with further, will turn out to be successful. A decision is then taken by the appropriate authority to :

- (i) continue with the project by providing more funds and allocating priorities, or
- (ii) discontinue so as to prevent further avoidable expenditure, modify, or suitably cut down the size of the project to fit it with the budget allotment. In case of abandonment of a project, the question of obtaining value for work done which can be salvaged and the disposal of fixed assets deployed on the project will also arise.

On completion of a project, the actual cost is compared with the budget and the variances explained. This would prove useful for the appraisal of similar projects to be undertaken in future.

An example to illustrate budgetary control of research projects is given below.

EXAMPLE 11.4.

You are required to prepare :

- (a) a statement of estimated research costs for RS Limited for the year 1973 ;
- (b) a research variance account for the year 1972.

The policy of RS Limited, in respect of certain types of their research projects, is to authorise them for a maximum of three years. Any incomplete project reaching the end of its authorised life may be resubmitted to the board of directors as if it were a new project.

During the currency of project the following are the maximum amounts of the total project cost authorised that can be included in the budget at different stages in its life :

For a 3-year project : 40% by the end of year 1

70% by the end of year 2

For a 2-year project : 60% by the end of year 1.

At an intermediate year's end, the difference, if any, between the amount authorised and the amount spent on a project is dealt with as follows :

- (i) If the amount spent is less than the maximum authorised for that stage, the difference is added to the authorised amount for the following year ;
- (ii) If the amount spent is more than the maximum authorised for that stage, twice the difference is deducted from the authorised amount for the following year. This acts as a deterrent to overspending.

In the last year of a project, any difference between the amount spent and the amount authorised is debited or credited (as appropriate) to a variance account. If the balance to this variance account is a debit at the end of the year, the bonus of the research staff for the following year is reduced by 20% of that debit balance. For every project completed, however, the bonus of the research staff for the following year is increased by 5% of the total cost authorised for those projects.

Administration and other overhead for the Research Department, not included in the project costs below, are budgeted at Rs. 28,500 for the year 1973 in which is included Rs. 5,000 of bonus for the research staff.

Data on research project are given below .

	Date started	Project No	Total project cost authorised Rs	Total cost incurred by end of 1972 Rs
Projects Authorised				
3-years projects				
	1970	C. 025	20,000	20,700
		C. 026	15,000	**14,800
		C. 027	12,000	**12,400
	1971	C. 928	10,000	6,400
		C. 929	24,000	17,200
	1972	C. 230	30,000	12,000
		C. 231	15,000	5,200
		C. 232	6,000	2,600
2-year projects				
	1971	B. 157	5,000	4,800
		B. 158	7,000	7,500
		B. 159	12,000	**12,750
		B. 160	4,000	4,300
	1972	B. 261	8,000	4,700
		B. 262	5,000	3,500
		B. 263	4,000	2,500
New Projects Authorised				
3-year projects				
	1973	C. 333/025	11,000	—
		C. 334	21,000	—
2-year projects				
	1973	B. 364	7,500	—
		B. 365	5,500	—
		B. 366	8,000	—

**These projects were completed during 1972

All projects not marked will be incomplete at 31st December, 1972

(Note The total cost incurred by end of 1972 is composed of actual cost upto 31st October, 1972 and estimated costs for November and December, 1972).

(I.C.M.A., Pt. II)

ANSWER .

(a) Statement of estimated research costs for 1973

Project Authorised	Project No	Budget 1972	Actual 1972	Budget 1973	Over-spending Adjustments	Total Budget
		Rs.	Rs.	(B) Rs.	(A) Rs.	(B-2A) Rs.
3-year Projects						
	C. 928	7,000	6,400	3,600	—	3,600
	C. 929	16,800	17,200	6,800	400	6,000
	C. 230	12,800	12,000	9,000	—	9,000
	C. 231	6,000	5,200	5,300	—	5,300
	C. 232	2,400	2,600	1,600	200	1,200
						<u>Rs. 25,100</u>
2-year Projects						
	B. 261	4,800	4,700	3,300	—	3,300
	B. 262	3,600	3,500	2,500	—	2,500
	B. 263	2,400	2,500	1,500	100	1,300
						<u>Rs. 7,100</u>

New Projects	C. 333/025	—	—	4,400	—	4,400
	C. 334	—	—	8,400	—	8,400
	B. 364	—	—	4,500	—	4,500
	B. 365	—	—	3,300	—	3,300
	B. 366	—	—	4,800	—	4,800
						<u>Rs. 25,400</u>
Total Project Cost	= Rs. 25,100 + Rs. 7,100 + Rs. 25,400 =					57,600
Bonus						*6,500
Other administrative costs etc						<u>23,500</u>
						<u>Rs. 87,600</u>

(b) Research variance represents the difference between amounts spent and amounts authorised in the last year of projects (1972)

Research Variance Account, 1972

Adverse Variances

	Rs
C. 025	700
C. 027	400
B. 158	500
B. 159	750
B. 160	300

Rs. 2,650 Dr

Favourable Variances

	Rs.
C. 026	200
B. 157	200

Rs. 400 Cr.

Balance Rs. 2,250 Dr.

* Bonus is calculated as follows . -

	Rs
Basic bonus	5,000
Less 20% of the Variance Account balance of Rs. 2,250	450
	<u>4,550</u>

Add increase of 5 % of projects completed .

	Rs.
C. 026	15,000
C. 027	12,000
B. 159	12,000
	<u>Rs. 39,000</u>
	1,950
	<u>Rs. 6,500</u>

Cash Forecast and Budget. Cash forecast precedes a cash budget. A cash forecast is an estimate showing the amount of cash which would be available in a future period. Cash is generated (cash inflow) in a concern from the collection of debts—the amounts received from the customers to whom products are sold and supplies are made—and from other cash incomes like rents, dividends and interest earnings on investments, proceeds from sale of capital assets, etc. Payment of cash (cash outflow) is required to be made to the creditors for purchases made and supplies received ; for wages, salaries and expenses ; and on account of capital

expenditure, dividends, investments, taxes, etc. Cash forecast takes into account all the sources from which cash is to be received and the channels in which payments are to be made during the stipulated period, so that a logical consolidated cash position is arrived at. For obvious reasons, no accrual items are included in the cash forecast.

Cash forecast and cash budget are instruments of planning rather than control. Without the cash forecast, it would not be possible to ascertain the requirements of the operating and capital budgets and occasions may arise when there may be either a shortage of cash so that budget commitments cannot be met, or there may be surplus funds which remain unutilized. The necessity for a cash forecast arises from the following :—

- (i) To indicate whether cash to the extent needed will be available for running the business ;
- (ii) To preserve liquidity ;
- (iii) To reveal the effect of sudden and seasonal requirements, large stocks, delay in collection of receipts, etc. on the cash position of the concern ;
- (iv) To determine when and where further funds are necessary ;
- (v) To assist in sound investment policy, both on a long-term and a short term basis, by revealing sources and extent of surplus funds ;
- (vi) To indicate whether funds are available internally for investment on plant expansion and replacement ;
- (vii) To indicate the availability of cash discounts ;
- (viii) To provide a basis for control of cash.

The length of the period for which a cash forecast should be made, depends upon how stable or how erratic are the demands upon the cash resources and what is the trend of the inward flow of funds. When payments and receipts are more or less stable throughout the year, annual forecasts would generally be made to fit in with the accounting period. Short-term forecasts covering a period of three to six months may be required when there is a seasonal variation in production and sales, or when purchases of raw materials are made in certain periods of the year to take advantage of a favourable market price. Short-term forecasts would also be essential when the concern is facing a shortage of cash. A short-term cash budget is desirable for current financial planning. As cash forecasts are not meant for performance evaluation or control, there should be no objection to frequently revising them. A better proposition, therefore, is to have a system of continuous budgeting on the basis of moving totals, i.e. to prepare quarterly or half-yearly forecasts, but revise them every month by dropping out the forecast for the oldest month and including the figure for the subsequent month. (See Page 560)

There are three methods of preparing cash forecasts :

(i) *Cash receipts and disbursements method* : The method is used for short-term forecasting of all money transactions during the period, receipts as well as payments, on the basis of the provisions made in the individual functional budgets including the capital expenditure budget. The main source of receipt of cash in a business is the collection from customers. The sales budget provides the figure for the probable cash receipt from this source. However, cash for the entire expected sales shown in the sales budget may not be forthcoming in a budget period. In

practice, credit is allowed to customers on varying terms and for varying periods. A forecast of the collections should, therefore, be made on the basis of the past average collection period. Other sources of receipt are financial and revenue receipts, like dividends, interest, royalties, etc., and capital receipts from sale of assets, loans received, investment returned, etc. The outflow of cash arises on account of revenue payments mainly for purchases of materials, wages, salaries, and other miscellaneous bills ; financial payments such as dividends, interest, taxes, etc., and capital payments. The amount to be disbursed for purchase of materials may be ascertained from the materials purchase budget which is adjusted to provide for the length of the credit period allowed by the creditors. Similarly, figures for payments to be made in respect of wages and expenses are available in the labour and expense budgets. For the purpose of cash forecasting, the amounts accrued but not paid during the budget period are excluded, but amounts paid in advance are included in the forecast. The figures for payments and receipts adjustable to capital are obtained from the capital expenditure budget.

In its final form, the cash forecast shows the opening balance of cash at the beginning of the period, to which the various cash receipt forecasts are added ; the expected cash payments are deducted from this sum to arrive at the forecast cash balance at the end of the period. A form suitable for presenting the forecast is given in Fig. 11.10.

SHORT-TERM CASH FORECAST				
	Period 1	Period 2	Period 3	Period 4
Opening balance				
Add Receipts :				
Cash sales				
Trade debtors				
Sales of capital assets				
Loans received				
Miscellaneous				
Less Payments :				
Trade creditors				
Cash purchases				
Wages & salaries				
Interest payable				
Loans given				
Capital expenditure				
Taxes				
Dividends				
Closing balance				

Fig. 11.10. Cash forecast (Payment and receipt method)

An example illustrating the preparation of a cash budget is given below :

EXAMPLE 11.5.

Prepare a Cash Budget for the six months ending 31st December, 19XX, from the monthly budgeted operating results of the company and other additional information given below :

Month	Sales	Materials purchased and consumed	Wages	Overheads				
				Production	Adminis- tration	Selling	Distri- bution	Research and Develop- ment
(Rupees in Lakhs)								
Mar	8 00	3 60	0 80	0 48	0 40	0 20	0 10	0 11
Apr	12 00	6 00	1 28	0 64	0 56	0 29	0 14	0 17
May	9 60	5 20	1 20	0 62	0 48	0 25	0 10	0 12
Jun.	6 40	3 36	0 56	0 30	0 20	0 11	0 06	0 06
Jul	8 00	3 84	0 80	0 44	0 32	0 16	0 08	0 10
Aug	8 80	4 00	0 96	0 49	0 40	0 21	0 10	0 12
Sep	11 20	4 96	1 20	0 62	0 52	0 26	0 12	0 13
Oct	12 80	6 00	1 04	0 54	0 40	0 20	0 10	0 12
Nov	14 40	6 40	1 36	0 72	0 56	0 29	0 15	0 16
Dec	16 00	8 00	1 52	0 74	0 58	0 30	0 16	0 17

New machinery which was installed in April at a cost of Rs. 1 20 lakhs is to be paid for on 1st August

Extension to the Research and Development Department amounting to Rs. 8 00 lakhs in total was contemplated from September at the rate of Rs. 1 60 lakh per month

Rs. 2 40 lakhs per month is to be paid under a hire purchase scheme agreement

Sales commission of 4 per cent on credit sales, not included in selling overheads, is to be paid within the month following actual sales

The period of credit allowed by suppliers is 4 months and that allowed to customers is 3 months. The delay in the payment of overheads is 2 months and that in payment of wages is one fourth of a month

Preference Share dividend of 8 per cent on the Capital of Rs. 160 00 lakhs payable on 1st December

8 per cent calls on equity shares, at the rate of Rs. 9 60 lakhs is due on 1st July, 1st September and 1st November

Taxation of Rs. 8 00 lakhs is payable on 1st November

Dividends on investment amounting to Rs. 2 40 lakhs is expected on 1st July and 1st December

Cash sales of Rs. 0 80 lakhs per month are expected on which no commission is payable

The cash sales are not included in the details for the sales given in the table above

Cash balance on 1st July was expected to be Rs. 2 00 lakhs (I C W A Final)

ANSWER

Cash Budget for the six months ending December, 19XX

	Jul	Aug	Sep	Oct	Nov	Dec
	(Rupees in Lakhs)					
Opening balance*	2 00	18 23	17 06	22 0*	20.66	20 58
RECEIPTS						
Debtors collection	12 00	9 60	6 40	8 00	8 80	11 20
Cash sales	0.80	0 80	0 80	0 80	0 80	0 80
Capital receipts	9 60	—	9 60	—	9 60	—
Dividend received	2.40	—	—	—	—	2 40
Total Receipts	24.80	10.40	16 80	8 80	19 20	14 40

*These are closing balances of the previous month carried over to the next month

PAYMENTS

Material purchased	3.60	6.00	5.20	3.36	3.84	4.00
Wages*	0.74	0.92	1.14	1.08	1.28	1.48
Overheads :						
Production	0.62	0.30	0.44	0.49	0.62	0.54
Administration	0.48	0.20	0.32	0.40	0.52	0.40
Selling	0.25	0.11	0.16	0.21	0.26	0.20
Distribution	0.10	0.06	0.08	0.10	0.12	0.10
R & D	0.12	0.06	0.10	0.12	0.13	0.12
Commission on sales	0.26	0.32	0.35	0.45	0.51	0.58
Capital expenditure	2.40	3.60	4.00	4.00	4.00	4.00
Tax	-	-	-	-	8.00	-
Dividend	-	-	-	-	-	12.80
Total Expenditure	8.57	11.57	11.79	10.21	19.28	24.22
Surplus/Deficit	16.23	(1.17)	5.01	(1.41)	(0.08)	(9.82)
Closing balance	18.23	17.06	22.07	20.66	20.58	10.76

*It is assumed that the wages are paid on a weekly basis (four times in a month for the purpose of cash estimation). Thus the payment made in any month consists of three-fourths of the wages for the current month and one-fourth of the wages due for the previous month.

(ii) *Balance Sheet change or Balance Sheet forecast method* : This method is useful for long-term forecasting of cash for a year, or for long periods. To the

CASH FORECAST

	Period 1	Period 2	Period 3	Period 4
Balance				
Additions				
Budgeted net profit				
Depreciation				
Provisions & Write off				
Capital receipts				
Accrued expenses				
Reduction in debtors				
Reduction in stocks				
Increase in liabilities				
Issue of capital				
Issue of debentures				
Total additions				
Deductions :				
Dividends				
Prepayments				
Capital payments				
Increase in debtors				
Increase in stock				
Decrease in liabilities				
Total deductions				
Balance				

Fig. 11.11. Cash Forecast (Profit forecast method)

opening balance of cash, all anticipated changes in Balance Sheet items such as debtors, stock, work-in-progress, depreciation, receipts from capital assets, advance payments, net profit before taxes, dividends, capital expenditure, and decrease in the amount due to creditors are added or deducted, as the case may be. The balance shows the estimated cash in hand at the end of the period.

This method does not take items of expenses into account and assumes that there is a regular pattern of inflow and outflow of cash. Another disadvantage of the method is that as it shows only the cash requirements at the end of a period, any surplus or deficiency of cash occurring within the budget period is not revealed.

(iii) *Profit forecast method* : This method which is based on the view that it is the profit which makes cash available, is also suitable for long-term forecasts. The net estimated profit is adjusted by adding back depreciation and provisions made before arriving at the profit, decrease in amount due to debtors, stock, and work-in-progress, capital receipts, accrued expenses and increase in creditors, and by deducting payments of unusual nature (like capital expenditure), dividends, prepayments, increase in stock and debtors, and decrease in creditors. The adjusted profit denotes the estimated cash available. A form of cash forecast based on this method may be seen in Fig. 11.11.

The cash forecast may reveal three likely positions. There may be cash just enough to meet the needs of the operating and capital budgets ; there may be a shortage of cash ; or there may be a surplus beyond the requirements of the current plan. In the first case, the cash forecast itself constitutes the cash budget, and no adjustments are necessary. In the other cases, the cash position should be co-ordinated with the activities of the business. In case of shortage of cash as revealed by the cash forecast, three courses are open : (i) if improvement in cash position is feasible, the forecast may be suitably adjusted, (ii) adjustments may be made internally by disposing of surplus funds in one budget to meet the requirements of the other budgets, or (iii) the functional budgets may themselves be adjusted to the extent of cash available. The adjusted cash forecast constitutes the cash budget and forms a part of the overall plan.

Capital Expenditure Budget. Fixed assets of a concern are comprised of land, buildings, roads, plant and machinery, vehicles, expensive tools, and other equipments. The cost of such assets is capitalised, keeping in view the basic principles of classification of expenditure into revenue and capital, viz. that expenditure which satisfies one of the following conditions should be capitalised :

- (a) It should benefit future periods ;
- (b) It should increase the serviceable life of the asset ;
- (c) It should contribute towards increase of efficiency and productivity of the asset.

The expenditure to be capitalised consists of the cost of acquisition or replacement of the asset and includes, besides the cost or purchase price of the asset, freight, customs duties, inspection charges, insurance, taxes, registration fees, brokerage, legal charges, cost of erection and installation, cost of improvements, alterations and additions, and major repairs which satisfy the conditions referred to above.

Capitalisation of fixed assets serves the following objectives :—

- (i) *Accounting and control of the stock of assets* : Details of all capital assets are recorded in a plant ledger or register or other registers for buildings and other equipments through the medium of a receipt voucher. Similarly, all additions to the assets and their disposal on sale or scrapping are entered in the appropriate folios or sheets of the plant ledger. The cost of capital works carried out departmentally, i.e. internally in the factory, is transferred to the charge of the ledger on transfer vouchers by giving corresponding credit to the relevant revenue heads of expenditure. The inventory of capital assets is verified physically at intervals and reconciled with the entries in the plant ledger in the same way as in the physical stock-taking of inventory. Physical verification ensures correct recording in the plant register, detects idle and unused plants, machinery, and equipment, and assists in pointing out in time, the need for maintenance and repairs.
- (ii) *Charging of depreciation* : As a capital asset benefits the production for a number of years, the cost of services rendered by it is suitably charged in the shape of depreciation charges to production costs throughout the working life of the asset.
- (iii) *Ensuring proper maintenance* of capital assets and giving timely attention to repairs and overhauls.
- (iv) *Control over the working life of an asset* : The serviceable life of an asset is properly assessed so that depreciation may be charged accurately. Idleness of plants and non-utilisation or over-utilisation of capacity are watched carefully, and revaluation of an asset is undertaken if it is found still serviceable after completion of its initially assessed life.

Capital expenditure budget is the plan of the proposed outlay on fixed assets and is very closely related to the cash budget. The availability of surplus cash resources as revealed in the cash budget may be the deciding factor for undertaking a capital project but more often, it is the other way round ; capital expenditure is dictated by requirements of production, and the cash budget is to be so established as to meet the needs of cash for the schemes laid down in the capital expenditure budget. The capital budget is also influenced by the sales budget. The capital requirements for development projects as revealed in the development budget should also be kept in view while framing the capital budget. It is, therefore, essential that the capital budget be properly co-ordinated with all the operational budgets of the concern so as to form an integral part of the overall plan.

Capital expenditure forecasting is a continuous process and by nature, it is a long-term function. Capital forecasts should be made for a number of years, say five years or even more. Along with the long-term forecast, there should also be a short-term forecast to cover the general budget period under consideration. Urgent projects needing immediate attention are included in the short-term forecast. As the business grows progressively, worn out assets such as production and service machinery, transport, office machinery, and building are to be renewed and replaced, the existing plants and machinery are to be modernised, and new assets are to be acquired to meet the increased load and diversified demands for the products. The requirements will be based on the demands made and the reports furnished by

the various departmental heads such as Production Engineer, Works Engineer, Sales and Distribution Executives, and the Office Manager. The management must be made constantly aware of all these requirements and for this purpose, there should be an efficient system of project appraisal and control of expenditure. These aspects are discussed in detail in Chapter 16.

Capital expenditure forecast serves the following purposes :—

- (1) It assists in estimating cash requirements for renewals, replacements and expansion of capital assets and cash receipts from such assets, disposed of
- (2) It provides the basis for estimation of depreciation and maintenance costs.
- (3) It reveals the possibility of expansion of production facilities to meet increased demands.
- (4) It forms a basis for long-term planning and policy making.
- (5) It enables consideration of alternative projects based on their respective profitability and other factors.

When the profitability of a capital investment plan has been evaluated and the project has received approval, it is incorporated in the capital expenditure budget. Priority amongst various projects is fixed and projects which cover long periods are properly phased. The capital budget for each period will show the

CAPITAL EXPENDITURE BUDGET							
	Period .						
	Original appro- priation	Expen- diture to date	Carry in from previous period	Fresh appro- priation dur- ing the period	Total	Budget provision for the period	Carry over to next period
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs	Rs	[(1) (2)] Rs	Rs	[(3) + (4)] Rs	Rs	[(5) - (6)] Rs
<i>Machinery and Equipment :</i>							
Automatic Machines for Production	3,50,000	2,00,000	1,50,000	—	1,50,000	1,50,000	—
Shop 3	60,000	—	60,000	30,000	90,000	90,000	—
Milling Machines	—	—	—	1,20,000	1,20,000	1,20,000	—
Cars and Vans							
<i>Building :</i>							
Additional wing in Hospital	80,000	20,000	60,000	—	60,000	60,000	—
Extension to Tool Room	—	—	—	30,000	30,000	30,000	—
Building Show- Room	—	—	—	1,30,000	1,30,000	70,000	60,000
Total	4,90,000	2,20,000	2,70,000	3,10,000	5,80,000	5,20,000	60,000

Fig. 11.12. Capital Expenditure Budget

Note : The amounts in Col. 4 should include revisions, if any, of the budget.

carry-in of the projects from the previous period, the amount to be appropriated during the current period, and the carry forward of the incomplete projects to subsequent periods. A specimen capital expenditure budget is shown in Fig. 11.12.

Master Budget. Master budget (also known as *summary budget* or *finalised profit plan*) combines all the budgets for a period into one harmonious unit and thus, it shows the overall budget plan. As profit planning is the main objective of a budget programme, it is but natural that all the subsidiary budgets should be co-ordinated and projected into a master or summary budget which should show the final projected results of the plan. The master budget incorporates all the subsidiary functional budgets and the budgeted Profit and Loss Account and Balance Sheet. Before the budget plan is put into operation, the master budget

Period .	MASTER BUDGET			
	Normal capacity :		Budgeted capacity	
	Product 1	Product 2	Product 3	To al
	Rs	Rs	Rs	Rs
Slaes				
Cost of sales				
Direct material				
Direct labour				
Variable Fy. overhead				
Fixed Fy. overhead				
Add Opening stock				
Less Closing stock				
Gross profit				
Administration cost				
Selling and distribution cost				
Net profit				
Assets :				
Fixed				
Current				
Total capital employed				
Ratios :				
Profit/Capital employed				
Sales/Capital employed				
Profit/Turnover				
Current ratio				
Liquidity ratio				
Appropriations from profit :				
Dividends				
Reserves				
Taxes				
Balance of Profit and Loss				

Fig. 11.13. Master Budget

is considered by the top management and revised if the position of profit disclosed therein is not found to be satisfactory. After suitable revision is made, the master budget is finally approved and put into action. An example of a master budget is given in Fig. 11.13.

Another view regards the budgeted Profit and Loss Account and the Balance Sheet as the master budget. The forms of budgeted Profit and Loss Account and Balance Sheet are shown in Fig. 11.14 and 11.15.

The Profit and Loss Account is built up from the other budgets already set, and no fresh estimates are necessary. The budgeted cost of production is deducted from the budgeted sales revenue in order to arrive at the budgeted gross profit. The operating profit is obtained by further deduction of the budgeted selling and distribution expenses. Addition and subtraction of other budgeted income and expenditure items give the budgeted net profit.

The *advantages* of a forecast Profit and Loss Account are as follows :—

- (1) It presents an overall projected profit position of the concern.
- (2) It enables the planning and control of the profits of the business.
- (3) It enables the investigation of causes for variances.
- (4) The accuracy of all the budgets are automatically checked.

The preparation of forecast Balance Sheet also is simple. This is prepared on the basis of the last Balance Sheet, wherein all forecast changes of assets and liabilities are included. The *advantages* of the forecast Balance Sheet are as follows :—

- (i) It reveals the overall financial position of the concern so that management may take action to improve it. The various forecast Balance Sheet ratios would be of assistance to the management in assessing the position.
- (ii) It enables a check to be exercised on the other budgets.
- (iii) The budgeted return on capital employed may be determined. Necessary changes may be made if the return is not considered to be adequate.

FORECAST PROFIT AND LOSS ACCOUNT			
	Period 1	Period 2	Period 3
Sales			
Cost of sales :			
Direct material			
Direct labour			
Variable Fy. overhead			
Fixed Fy. overhead			
Add Opening stock			
Less Closing stock			
Gross Profit			
Administration expenses			
Selling and distribution expenses			
Add Other incomes			
Less Other deductions			
Net profit (before taxes)			

Fig. 11.14. Forecast Profit and Loss Account

FORECAST BALANCE SHEET			
	31st October 19—	30th November 19—	31st December 19—
Assets :			
Cash			
Debtors			
Stock			
Fixed assets			
Total			
Liabilities :			
Creditors			
Dividends			
Taxes			
Total			
Net Worth :			
Capital			
Reserves and Profit			
Total			

Fig. 11.15. Forecast Balance Sheet.

The method of preparation of Forecast Profit and Loss Account and Forecast Balance Sheet is illustrated in the example given below :

EXAMPLE 11.6.

This book of a Company shows the final position as follows :

PROFIT AND LOSS ACCOUNT
for the year ending 31st December, 1973

Dr.			Cr.
	Rs.		Rs.
To Materials consumed	36,000	By Sales	1,26,000
„ Wages	12,000		
„ Manufacturing overheads :			
Variable expenses	4,200		
Fixed expenses	3,000		
Depreciation	3,000		
„ Administration overheads	4,000		
„ Selling and Distribution overheads :			
Variable expenses	6,000		
Fixed expenses	2,000		
„ Net profit	55,800		
	<hr/> 1,26,000		<hr/> 1,26,000
„ Income Tax	23,000	„ Net profit	55,800
„ Dividend	12,000		
„ Balance c/d	20,800		
	<hr/> 55,800		<hr/> 55,800

BALANCE SHEET
as on 31st December, 1973

Liabilities	Rs.	Assets	Rs
Share capital	2,00,000	Fixed assets (written down)	2,00,000
Reserves and surplus	19,000	Stock of materials	20,000
Sundry creditors	20,000	Sundry debtors	29,000
Provisions		Cash	25,000
Tax	23,000		
Dividend	12,000		
	Rs 2,74,000		Rs 2,74,000

With the help of the following additional information, you are required to prepare a Forecast Profit and Loss Account for the year 1974 and a Forecast Balance Sheet as on 31st December, 1974

- | (i) | Present

(1973) | Future

(1974) |
|------------------------------------|----------------------------|--------------------------------|
| Capacity utilised | 60% | 80% |
| Units produced | 60,000 | |
| Sale price per unit | Rs 2.10 | Rs 2.30 |
| Material | | Price increase of 25% expected |
| Wages | | 10% increase in rates expected |
| Manufacturing overheads | | 10% increase in costs expected |
| Administration overheads | | 5% " " " " |
| Selling and distribution overheads | | 10% " " " " |
| Capital expenditure | | Rs 60,000 |
| Depreciation | | Rs 3,000 per year |
| Income Tax | | Rs 50,000 |
| Dividend | | Rs 20,000 |
- (ii) Period allowed To debtors --one month
By creditors--two months
Stock of raw materials maintained--3 months' requirement
Time lag in payment of wages and expenses being insignificant may be ignored
- (iii) There is no stock of finished goods at the year end. (I.C.W.A., Final)

ANSWER :**Sales budget :**

Units $\frac{80}{60} \times 60,000$ 80,000 at Rs 2.30

Sale value--Rs 1,84,000

Purchase budget (Materials) :

	Rs
Consumption during 1973	36,000
Add 33 1/3% for increase in capacity	12,000
	48,000
Add 3 months' stock to be held	12,000
	60,000
Less Opening stock	20,000
	40,000
Price increase of 25%	10,000
Total requirement	Rs. 50,000

Consumption during 1974 :

	Rs.
Opening stock	20,000
Add Purchase	50,000
Less Closing stock	15,000
$(12,000 \times \frac{125}{100})$	<u>Rs. 55,000</u>

Rs.

Wages budget :

Wages paid in 1973	12,000
Add 33½% for capacity increase	4,000

16,000

Add 10% for rate increase

1,600Rs. 17,600

Overhead budget :

Manufacturing Overheads :

Variable expenses	4,200
Add 33½% for volume increase	1,400

5,600

Add 10% for cost increase

560

Rs. 6,160

Fixed expenses

3,000

Add 10% for cost increase

300

Rs. 3,300

Depreciation

Rs. 3,000

Administration Overheads :

Expenditure during 1973	4,000
Add 5% for cost increase	200

Rs. 4,200

Selling and Distribution Overheads :

Variable expenses	6,000
Add 33½% for volume increase :	2,000

8,000

Add 10% for cost increase

800

Rs. 8,800

Fixed expenses

2,000

Add 10% for cost increase

200Rs. 2,200

Cash budget :

Receipts :

Rs.

Opening balance	25,000
-----------------	--------

Debtors (Sales)

Opening balance	29,000
-----------------	--------

Sales	1,84,000
-------	----------

Less Closing balance

$(1/12 \times 1,84,000)$	15,333
--------------------------	--------

1,97,667Rs. 2,22,667

Payments :

Creditors (Purchases)

Opening balance	20,000
Purchases	50,000
Less Closing balance (2/12 × 50,000)	8,333

61,667

Wages

17,600

Overheads :

Manufacturing

9,460

Administration

4,200

Selling and distribution

11,000

Income Tax

23,000

Dividend

12,000

Capital expenditure

60,000

Rs 1,98,927

Closing balance

Rs 23,740

FORECAST PROFIT AND LOSS ACCOUNT

Dr				Cr
	Rs		Rs	
To Materials consumed	55,000	By Sales	1,84,000	
Wages	17,600			
Manufacturing overheads				
Variable expenses	6,160			
Fixed expenses	3,300			
Depreciation	3,000			
Administration overheads	4,200			
Selling and Distribution overheads				
Variable expenses	8,800			
Fixed expenses	2,200			
Net Profit	83,740			
	<u>1,84,000</u>			
Income Tax	50,000	Net Profit	<u>1,84,000</u>	
Dividend	20,000		83,740	
Balance c/d	13,740			
	<u>83,740</u>			
			<u>83,740</u>	

FORECAST BALANCE SHEET

as on 31st December, 1974

Liabilities	Rs	Assets	Rs
Share Capital	2,00,000	Fixed Assets	
Reserves and Surplus		Opening value	2,00,000
Balance	19,000	Less Depreciation	3,000
Profit this year	13,740	Addition	60,000
	<u>32,740</u>	Closing Stock (materials)	15,000
Sundry Creditors	8,333	Sundry Debtors	15,333
Provisions		Cash	23,740
Tax	50,000		
Dividend	20,000		
	<u>Rs. 3,11,073</u>		<u>Rs. 3,11,073</u>

Budget Reports. Performance evaluation and reporting of variances is an integral part of all control systems. Establishing budgets is in itself of no avail unless a comparison is made regularly between the actual expenditure and the budgeted allowances, and all results reported to the management. For this purpose, budget reports showing the comparison between the actual and budgeted expenditure should be presented periodically in a tabular form (Fig. 11.16) or in graphs (Fig. 11.17). The reports should be prepared in such a manner that they reveal the responsibility of a department or an executive and give full reasons for the variances so that proper corrective action may be taken. The reporting should be on the principle of exception and both favourable and unfavourable variances should be shown and commented upon. A form of variance analysis report showing the corrective action taken is given in Fig. 11.18.

Department	BUDGET REPORT				
	Period :				
Expenses	Budget Rs.	Actual Rs.	Difference		
			Increase Rs.	Decrease Rs.	Reasons
Controllable expenses :					
Repairs to tools					
General shop labour					
Machine maintenance					
Electrical maintenance					
Power and lighting					
Repairs to machinery					
Sundry shop stores					
Lubricants					
Non-controllable expenses :					
Floor space expenses					
Plant Depreciation					
General prorated overhead					
Total					

Fig. 11.16. Budget Report for Expenses

Revision of Budgets. It is essential to revise budgets whenever necessary, in order to fit them with the changing business conditions. Revision of budgets may be required under the following circumstances :—

- Change in external factors, such as change in wage rates, prices of materials and fixed assets, etc.
- Errors in budgets detected later.
- Additional expenditure to meet contingencies of an unforeseen and sudden nature. If the additional expenditure is of a temporary nature, normal budgets may be reverted to as soon as the contingency is over.

The same routine as followed for setting of normal budgets is adopted for revising budgets. The circumstances necessitating the revision are ascertained, the revised forecast is scrutinised and co-ordinated with other budgets, and final sanction is accorded for the revision by the appropriate authority.

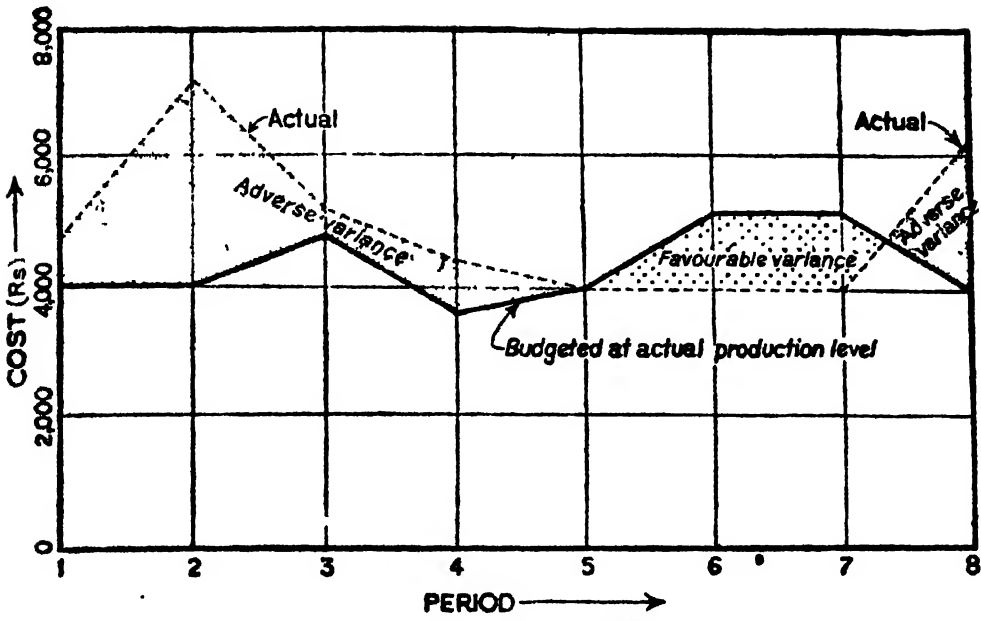


Fig 11.17 Budget Variance Chart

VARIANCE ANALYSIS			
Month . Jan 1986		Standing Order No . 02 0034, 14	
Responsibility Centre . Deptt. 14		Expense : Indirect labour	
Report by Budget Control			
Budget	Actual	Variance	Reasons identified
4,850	6,500	(-), 1,650	Excess labour strength
Corrective Action Report by Department			
1. Cause of variance.		Four workers over the number allowed in the budget.	
2. Plan of corrective action (This should have a positive approach and no request for increase of budget. If no corrective action is suggested, state reason.)		Action in hand to transfer three workers to Deptt. 09 and to deploy one man on direct produ. on job	
3. Effect on annual budget (whether it can be beaten, met or overrun)		Will be met	
Sd. Budget Controller		Sd. Department Head	
Variances exceeding 10% of the budget or Rs. 2,000 (whichever is lower) are only to be reported.			

Fig. 11.18. Variance Analysis Report

Limitations of Budgets. The advantages derived from a budgetary control system are so obvious that there would hardly be any enterprise where the system would not be in use in one form or the other. Despite such a wide application, budgets have certain limitations that should be kept in view and taken care of if full and effective use of the budgetary system is to be made. These *limitations* are :—

- (i) Half-hearted or erroneous budgeting creates confusion. The budget system should, therefore, be installed and operated with sufficient care.
- (ii) After all, budgets are only estimates and estimating cannot be an exact science. In many jobbing industries, budgets cannot be established with reasonable accuracy. To the extent they are not achieved, budgets will be inaccurate and their utility subject to doubt. However, numerous quantitative techniques are available that are capable of making estimation accurate to a large degree ; these together with sound reasoning and judgement should enable the establishment of fairly effective budgets.
- (iii) Budgets fixed for a particular level of activity are required to be constantly revised to fit in with the level achieved. However, this may to some extent be obviated by the use of flexible budgets.
- (iv) Like all other tools of management, the success of a budgetary control system depends upon how efficiently it is operated. Budgeting is not an automatic process that could be a substitute for managerial ability. A continuous budget consciousness and whole-hearted participation in the budget programme at all levels of management should produce satisfactory results.
- (v) In course of time, budgets become mechanical and a spoon-feed for the executives who no longer bother about achieving them. The remedy lies in proper education, and in fixing not very rigid but achievable budgets. The budget system should be dynamic and flexible so that it can be continually adapted to changing circumstances.
- (vi) As in any other system of responsibility accounting, there is a tendency on the part of the executive concerned to show off and try to pass on his mistakes to others.

Responsibility Accounting. Responsibility accounting is a system of control by delegating and locating responsibility for costs. Responsibility accounting follows the basic principles as for any system of cost control like budgets and standard costs, with the difference that it has a bias towards fixation of responsibility on individuals, departments, or machines. These principles are as follows :—

- (1) A plan of objective is set up in terms of a target, budget, standard, or estimate. The plan is sub-divided for allocation to each responsibility area or centre and is communicated to the concerned level of management.

- (2) The performance is evaluated, i.e. the results of actual operation by each responsibility area are ascertained.
- (3) The variances from the plan are analysed to fix responsibility on the responsibility area or centre. The variances are reported to the higher management.
- (4) Corrective action is taken and communicated to the individual responsible.

In the concept of responsibility accounting, distinction is to be made between controllable costs and uncontrollable costs.

Controllable costs are costs which can be influenced by the action of a specified member of an undertaking. Controllable costs incurred in a particular responsibility centre can be influenced by the action of the level of management responsible for the centre. Direct costs, comprising direct labour, direct material, direct expenses and some of the overhead expenses are generally controllable by the shop level management.

Cost which cannot be influenced by the action of a specified member of an undertaking are known as *uncontrollable costs*. For example, the overhead expenditure that is incurred by one servicing section or shop and is apportioned to another which receives the service is not controllable by the latter. Expenditure incurred by, say, the tool room is controllable by the foreman in charge of that section but level of costs, i.e. the share of the tool room expenditure apportioned to a machine shop is not to be controlled by the machine shop foreman. Similarly, the costs of the personnel, accounts and other such departments and general factory administration costs allocated to the operating department cannot be controlled by the latter.

The distinction between controllable and uncontrollable costs is not very sharp and is sometimes left to individual judgment. In fact, no cost is uncontrollable; it is only in relation to a particular individual or level of management and the time span covered that we may specify a particular cost to be either controllable or uncontrollable. All costs are controllable by some one at some time. As we have seen above, an expenditure uncontrollable by one individual may be controllable so far as another individual is concerned. Then again, an expenditure uncontrollable on the short-term basis due to the current circumstances may be controlled on a long-term basis, when the conditions improve. Costs of depreciation, rent or taxes may be uncontrollable at a particular point of time but when opportunity arises for a review and fresh commitments are being made on these accounts, the top-level management can subject these to appropriate control. In sum, controllability of an item of cost would depend upon the area of managerial responsibility and the time factor involved.

The main requirement of a system of responsibility accounting is that the organisation should be such that the responsibility of each individual may be clearly defined; each executive would know what he is required to do and what performance is expected from him, with regard to the cost controllable by him.

The system of accounting and reporting is fitted into the various responsibility areas so that the performance of each area is evaluated and reported for improvement. Thus, responsibility accounting lays stress on planning and cost control rather than on cost ascertainment, and its main advantages lies in the prompt reporting of performances of executives at various levels of management.

In a system of responsibility accounting, focus is on identifying the costs that the departmental manager is responsible for controlling. If the department has been constituted into a profit centre, there is a further emphasis on sales revenue and profitability. Costs and revenues not controllable by the manager need not be included in his responsibility budget nor should these be reported to him. Thus responsibility reporting is different from the usual operating performance reporting. Responsibility reports contain only the controllable items and non-controllable costs if included at all are for general information only in the context of the overall performance of the company.

A conventional operating statement for external financial reporting may be seen in Fig. 11.19. The information has been recast (Fig. 11.20) in more details in a format suitable for internal control under cost centre and profit centre concepts. Another report suitable only for cost centre responsibility accounting may be seen in Fig. 11.21.

CONTROL REPORT

Department :	Period		
	Budgeted	Actual	Variance (Favourable or Adverse)
Production (units)	Rs.	Rs.	Rs.
Controllable costs :			
Direct Materials			
Direct Wages			
Sundry supplies			
Indirect labour			
Maintenance			
Total controllable costs			
Non-Controllable costs :			
Building maintenance			
Depreciation			
Other allocated costs			
Total non-controllable costs			
Total costs			
Comments on Variances :			

Fig. 11.19. Responsibility Cost Centre Report

OPERATING STATEMENT

	Year ending			
	Actual Rs (in lakhs)	Budget Rs (in lakhs)	Variance from budget Rs (in lakhs)	
Sales	30.0	32.0	2.0(A)	6.25
Less Production costs	20.5	20.5	0	
Gross profit	9.5	11.5	2.0(A)	17.4
Selling, distribution and administration expenses	6.0	6.0	0	
Operating Profit	3.5	5.5	2.0(A)	36.36
Other income	0.5		0.5(F)	
Profit before tax	4.0	5.5	1.5(A)	27.3
Taxes	2.0	2.8	0.8(F)	28.6
Net profit	2.0	2.7	0.7(A)	25.9
Return on capital employed	7.4%	10%		
Profit/Sales (%)	6.67%	8.44%		
Residual income (Rs. lakh)	0.4	1.0		

Fig 11.20 Operating Statement

CONTROL STATEMENT

Profit Centre	Period			
	Actual Rs (in lakhs)	Budget Rs (in lakhs)	Variance from budget Rs (in lakhs)	
Sales	30.0	32.0	2.0(A)	6.25
Cost of sales				
Direct materials	6.0	6.5	0.5(F)	7.69
Direct wages	8.5	8.4	0.1(A)	11.9
Other production costs	6.0	5.6	0.4(A)	7.1
Marketing	2.0	2.0	—	
Finance	2.5	2.8	0.3(F)	10.7
Administration	1.5	1.2	0.3(A)	25
	26.5	26.5	—	
Other income	0.5		0.5(F)	
Profit before tax	4.0	5.5	1.5(A)	27.3
Tax	2.0	2.8	0.8(F)	28.6
Net profit	2.0	2.7	0.7(A)	25.9
Return on capital employed	7.4%	10%		
Profit/Sales (%)	6.67%	8.44%		
Residual income (Rs. lakhs)	0.4	1.0		

Fig 11.21 Profit Centre Control Statement

Performance Budgeting. The emphasis nowadays is on performance-oriented budgets that are established in such a manner that each item of expenditure related to a specific responsibility centre is closely linked with the performance of that centre. The basic issue involved in the fixation of performance budgets is that of

developing work programmes and performance expectations by assigned responsibility, necessary for the attainment of the goals and objectives of the enterprise. Earlier in the conventional system of budgeting, the money concept had been given more prominence : budgeting was directed almost exclusively towards estimating or projecting rupee value for the various accounting heads or classifications of revenue and costs. The main defect of the conventional system prevalent in Government departments and in many business enterprises, is that the most important facet of budgeting, viz. control of the performance in terms of physical units and the related costs cannot be achieved. It may be noted that the budgets of manufacturing concerns are mainly performance-oriented since the functional budgets are established basically in terms of performances related to the physical performances of the primary divisions, viz. the sales and the production divisions.

The steps involved in the establishment of a successful system of performance budgeting are :

- (i) Establishment of well defined centres of responsibility or the action points where operations are performed and where financial transactions in terms of money take place.
- (ii) Establishment for each responsibility centre, a programme of target performance in physical units. Such targets are usually the expected physical achievement of that centre. For instance, the performance target for a sales department may be set in terms of units of products to be sold and for a production department, it would be the unit of products programmed to be manufactured. Similarly in the case of capital works, the performance target may be established in terms of the quantum of work likely to be done during the budget period and so on.
- (iii) The next step is to forecast the amount of expenditure under the various classification heads, required to meet the physical plan laid down as per the procedure in para (ii) above. Thereafter, the procedure of budgeting would follow the usual routine as in the case of any other type of budgeting.
- (iv) Evaluation of performance in two stages : in the first stage, the actual physical performance is compared with the physical target with the twin objectives of, (a) determining the extent of deviation, and (b) adjusting the original rupee budget into a budget allowance for the actual physical work performed. In the second stage, the actual expenditure is compared with the adjusted budget or the budget allowance in order to determine the monetary variances. The following illustration will explain the procedure :

Performance Budget for Generation of Electricity

Physical : Budgeted units of electricity to be generated		1,500 MKWH
Less auxiliary consumption (8%)		120 MKWH
Budgeted units to be sent out		<hr/> 1,380 MKWH
Budgeted expenses for fuel :		
Variable	Rs. 7,20,00,000	
Fixed	Rs. 80,00,000	
	<hr/> Rs. 8,00,00,000	

Actual Performance

Physical : Units generated	1,400 MKWH
Less auxiliary consumption	140 MKWH

Units sent out	1,260 MKWH

Budget allowance or adjusted budget for actual performance

$$\text{Rs. } 80,00,000 - \text{Rs. } 7,20,00,000 \cdot \frac{1,260}{1,380}$$

Rs. 7,37,39,000 (rounded off)

Actual expenditure on Fuel : Rs 7,50,40,000

Deviation

Shortfall in physical target	1,380	1,260	8.7%
	1,380		

Variance amount Rs 7,37,39,000 minus Rs. 7,50,40,000 Rs 13,01,000 (A)

- (v) Performance reporting indicating the result of analysis of the variances from the budgets is done in the usual manner as in the case of variance reporting.

In the government system of accounting, expenditure is classified, under the Main Budget Heads, according to the nature or object of expenditure such as pay and allowances, supplies, equipments, transport etc. For the operation of performance budgeting, a third type of classification of expenditure according to each function, activity or project is required. For example, the construction of a bridge, setting up of an ordnance factory, building railway lines in a particular region, etc. may be classed as projects under the various Ministries. These may be further classified into various sub-activities for the purpose of performance budgeting and control.

The budgets for each activity or sub-activity are set both in terms of costs (and revenue) and physical targets. Once the budget is sanctioned, the department concerned starts the work, obtains funds in regular flow against the physical targets, takes action for preventing over-runs and under-spending and submits periodical reports to the higher authorities regarding the achievement of physical targets against the funds spent. Variances from the monetary and physical targets are analysed in the usual manner and corrective action taken, as necessary.

Program Budgeting (or Planning, Programing and Budgeting System PPBS). This is a budgetary process meant to make government operations more effective and efficient. Developed in the U.S.A. in 1961, program budgeting is being used in the various departments of the U.S. Government. Some of the features of program budgeting that distinguish it from the conventional budgeting and performance budgeting are as follows : -

1. Program budgeting reconstructs budgets by accounting expenditure under output categories rather than objective categories. Budgets are established for each activity leading to the output such as defence, health, education etc.
2. Program budgeting is prospective : the other types of budgets are retrospective. Program budgeting connotes planning in the real sense.

3. Program budgeting is concerned with the purpose of work and not as much with the process of work. As a result, the problems of program budgeting are the problems of the top level management dealing with strategy. The process of the other types of budgeting is concerned with the problems of the lower and middle levels of management.

4. Program budgeting extends beyond one financial year and depending upon the activity concerned, it may extend for a long term, say two to five years till the final output is achieved.

5. Program budgeting is closely associated with cost benefit analysis.

The process of program budgeting consists of the following five stages :—

(a) *Program accounting* : A program is a collection of activities that have the same purpose and function together to produce the same output. For instance in a programme of Personal Safety, *law and order enforcement* may be a sub-programme that may be further expanded into a number of activities such as prevention of crime, detection and investigation of crime, judiciary for judging and awarding punishment, and jail administration.

Program accounting has a twofold function, viz.

(i) to define a number of programs and list aggregate expenditure according to the programs they serve, and

(ii) to ascertain all the expenses including capital outlays that are chargeable to each program.

(b) *Multiyear Costing* : This focuses on the total cost of a program that may not run just for one financial year only but may continue for a number of years ahead. Thus a program budget will show estimated costs for the current budget year as well as for several future years to cover the entire life of a program or project.

(c) *Description and measurement of activities* : The procedures in this phase are as follows :—

Description ;

Determination of objectives, i.e. the long term goals (for example, to raise the earning capacity of poor people) ;

Determination of targets, i.e. short term goals (for example, providing for agriculture improvement, establishment of industrial estates etc.) ;

Decide upon a course of action ;

Consider the alternatives rejected in preference to the choice action ;

Determine the output ;

Measure the effectiveness, i.e. the degree to which objectives or targets have been achieved.

(d) *Zero Base Budgeting* : This refers broadly to the procedure for the review of the total expenditure proposed for a program instead of mere changes from the appropriations made previously for that program. Zero Base Budgeting is discussed in the next section.

(e) *Cost Benefit Analysis* : This refers to the quantitative evaluation of alternatives, the objective being to rank alternative use of funds.

The technique of cost benefit analysis is used by the decision maker who has to make a choice between a number of alternative projects. The costs of each of the alternatives are compared with the likely benefits to be achieved from each

project, the purpose being to select the one that gives the maximum benefit with the minimum cost. While in the case of products, the benefits may be measured in terms of market output, the benefits in the case of services, non-profit making organisations and government bodies may be taken as the extent of service, saving in foreign exchange, workers' training, employment generation and such other social benefits.

Since maximisation of benefits and minimisation of costs cannot be done simultaneously, the aim is to :

- (i) maximise benefits for given costs ; or
- (ii) minimise costs while obtaining a stipulated level of benefits ; or
- (iii) maximise net benefits (i.e., benefits minus costs).

The criteria commonly used in costs benefit analysis are :

- (i) Benefit cost ratio, expressed as a percentage,

$$\frac{\text{Benefits}}{\text{Costs}} \times 100$$

- (ii) Internal rate of return of the various alternatives discounted to their present values. (This is discussed in a later chapter.)

In the context of program budgeting, special studies are made to review in terms of costs and benefits the effectiveness of alternative efforts and to compare alternative mixes of programs.

Zero Base Budgeting. The technique of *Zero base operational planning budgeting* (commonly termed *Zero Base Budgeting*) differs from the conventional system of budgeting mainly in that in the budgeting of a function, the start is from scratch or zero and not on the basis of trends or historical levels of expenditure. In the customary budgeting system, the last year's figures are extrapolated to become the basis of the next year's budget—the historical figures are accepted as they are, or cut back or increases are granted. Zero base budgeting on the other hand, starts with the premise that the budget for the next period is 'zero' so long the demand for a function, process, project, or activity is not justified for each rupee from the first rupee up. The assumption is that without such a justification, no spending will be allowed. The burden of proof thus shifts to each manager to justify why the money should be spent at all and to indicate what would happen if the proposed activity is not carried out and no money is spent. In this way, he is required to carry out cost-benefit analysis of each of the activities etc. under his control and for which he is responsible. Such analysis would reveal that some activities are less essential or have less pay value for money than the others and that some activities may be eliminated or curtailed or made into productive and profitable ones. Thus zero base budgeting affords a choice amongst the alternatives so that the activities would be selected in the order of their importance.

In the actual conversion process of raw materials into finished products, however, costs cannot be zero because for the manufacture of goods for sale, costs have to be incurred on purchase of materials, payment of operative wages, use of power and other services etc. Zero base budgeting meets such situations by asking the managers to determine the minimum or basic requirements for running their departments ; any costs above the basic requirement would be treated as added increments which would be critically reviewed and justified. If

these cannot be justified, they are to be eliminated resulting in cost saving to the enterprise. However, zero base budgeting is particularly suitable in discretionary cost areas such as marketing, administration, production services, research, etc. and in government departments where the decision for the extent of spending rests with the management or authorities and it is here that each rupee of the budget has to be justified.

The first step in the process of zero base budgeting is to develop an operational plan or decision package. A decision package identifies and describes a particular activity with a view to,

- (i) evaluating and ranking the activity against other activities competing for the same scarce resources, and
- (ii) deciding whether to accept or reject or amend the activity.

For this purpose, each package should give details of costs, returns, purpose, expected results, the alternatives available and a statement of the consequences if the activity is reduced or not performed at all.

An illustration of work packages is given below.

Program Establishment of a Health Unit				
Work Package No.	Package target	Budgeted incremental costs		
1	Setting up out-door dispensary with equipments, medicines but no medical staff	0	Rs	50,000
			Rs	50,000
2	Providing minimum staff	Rs 50,000	Rs	30,000
			Rs	50,000
3	Purchase of more equipments and medicines and providing more staff in the 2nd phase	Rs 80,000	Rs	1,20,000
			Rs	2,00,000
4	Special equipments and specialist staff and 3 beds for emergency	Rs 2,00,000	Rs	2,00,000
			Rs	4,00,000
5	Establishment of 30 bedded hospital	Rs 4,00,000	Rs	16,00,000
			Rs	20,00,000

It will be seen that package nos. 1 and 2 go together since package no. 1 alone will give no benefit. Package nos. 3, 4 and 5 will be acceptable in that order provided funds as indicated by the incremental costs are available and cost benefit analysis of each package justifies its acceptance.

The particular *advantages* that zero base budgeting offers are :

- (i) Out of date and inefficient operations are identified.
- (ii) Allows managers to promptly respond to changes in the business environment.
- (iii) Instead of accepting the current practice, it creates a challenging and questioning attitude.

- (iv) Allocation of resources are made according to needs and the benefits to be derived.
- (v) Has a psychological impact on all levels of management which makes each manager to 'pay his way'.

Profit Planning, Control, and Improvement. The net profits a company expects to earn after meeting all outside obligations including taxes should in the long run be sufficient to provide for the replacement of fixed assets at current level of prices, for ploughing back funds for the normal growth of the business and for payment of reasonable dividends to the shareholders. Based on these requirements, each company would plan its profits or in other words, lay down target of profit expected in a specified period and incorporate it in the budget plan. Mainly a management function, profit planning calls upon a study of the interrelationship between prices, sales volume, fixed costs and variable costs, each of which affects earnings. Profit planning and control utilizes the following techniques :—

- (a) Budgeting and budgetary control.
- (b) Marginal costing.
- (c) Cost-volume-profit analysis and break-even charts.
- (d) Differential and comparative cost analysis.

These techniques are discussed in the various chapters of this text.

An illustration of a profit improvement plan may be seen in Fig. 11.22. Profit improvement may be achieved by taking one or more of the following measures :—

- (i) *Increase in sales.* Other things remaining constant, profits may be increased by increasing the volume of sales, even by reducing the selling price, or by increasing the selling price, provided the market conditions permit such a course being taken.
- (ii) *Cost reduction.* Any reduction in costs will go to increase the profit.
- (iii) *Better product mix.* The various methods in use for analysing the profitability of alternative combinations of products were discussed earlier. The product mix should be such as to yield the largest profit subject to the restrictions imposed by the limiting and other factors.
- (iv) *Minimum capital investment.* Heavy investments in capital assets and inventory involve higher rate of depreciation and maintenance cost, payment of interest, and risk of obsolescence. An ideal capital investment would be the one which needs the minimum cash layout and at the same time, results in the most economic working of the undertaking, so as to maximise profit.

As far as practicable, a business should have a profit improvement plan built in the organisation itself. There may be a profit improvement committee for sanctioning and following up improvement proposals. A minimum profit or rate of return on each investment or product line is set up as a target. Alternative proposals for improving profit are studied and scrutinized and the best course selected for adoption as the plan. A follow up system should exist in order to report the performances and deviations from the plan. The particular method adopted for improving profit will depend upon specific circumstances and no

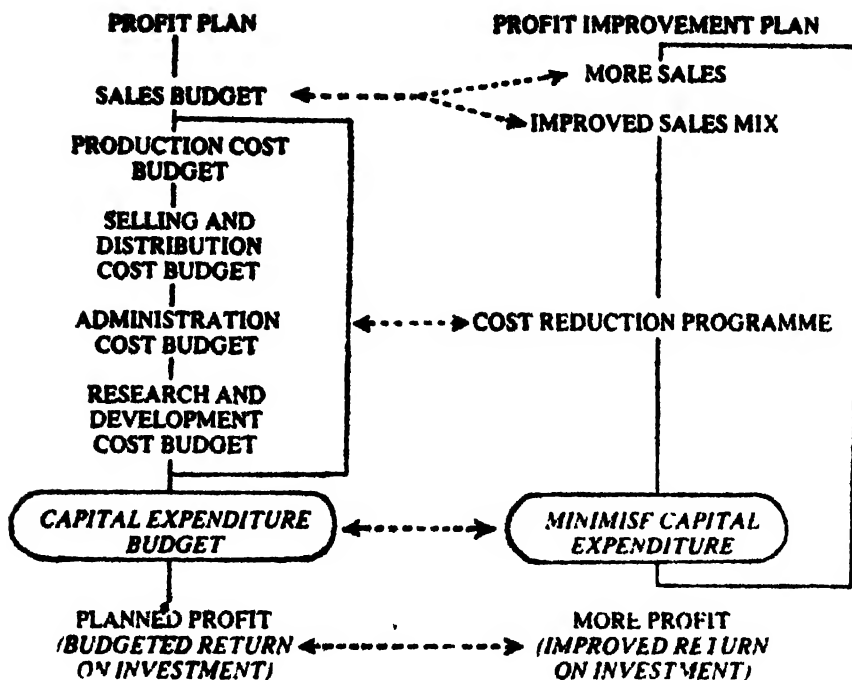


Fig. 11 22 Profit Improvement Plan

readymade or standard plan can be suggested for a business. Two examples which follow will serve to illustrate the techniques used for improvement of profit under given sets of conditions.

EXAMPLE 11.7

The operating results for a particular year in respect of a company manufacturing a sole product which is processed through two producing departments A and B are given below.

Sales	10,000 units
Price	Rs. 10 per unit
Cost of material	Rs. 2 per unit
Cost of labour, Deptt. A	10,000 hours @ Rs. 1 per hour
Cost of labour, Deptt. B	6,000 hours @ Rs. 1.50 per hour
Variable overheads, Deptt. A	Rs. 1 per direct labour hour
Variable overheads, Deptt. B	Rs. 2 per direct labour hour
Fixed overheads	Rs. 27,000 per year

The production manager of the company has put forth a scheme which would utilise a cheaper substitute for the raw materials. The scheme, if adopted, is expected to result in cost reduction to the following extent :

Material—Reduction from Rs. 2 to Rs. 1.50 per unit.

Labour and variable overheads—10 per cent increase in Deptt. A.

The sales manager has pointed out that there is a potential market for the product which can absorb another 2,500 units provided the price is cut down by 5 per cent for the entire production. Increase in capacity will result in increasing capital employed from Rs. 48,000 to Rs. 60,000. There will also be a rise in the fixed overheads to the extent of Rs. 3,000 because of extra depreciation.

You are required to prepare a comparative statement and to give your comments on the schemes.

(I.C.W.A., Final)

ANSWER :

The present profit and the anticipated profit under the proposed plan are :

	Present Rs.	Proposed Rs.
Sales	1,00,000	1,18,750 (12,500 × Rs. 9.5)
Costs :		
Material	20,000	18,750 (12,500 × Rs. 1.5)
Labour A	10,000	13,750 (12,500 × Rs. 1.1)
Labour B	9,000	11,250 (Labour hrs., 6,000 + 1,500)
Variable overhead A	10,000	13,750
Variable overhead B	12,000	15,000
Fixed overhead	27,000	30,000
Total cost	88,000	1,02,500
Gross profit	Rs. 12,000	Rs. 16,250
Profit/sales	12%	13.7%
Capital employed	Rs. 48,000	Rs. 60,000
Profit/capital employed	25%	27%
Turnover (Sales/capital)	2.08	1.98

The proposal is recommended on the following grounds :

- Increase in gross profit and return on capital employed.
- Reduction in cost per unit.
- Increase in fixed overhead is about 11% only for an increase of 25% in production.
- The additional investment is paid back in about three years' out of the additional profit.

EXAMPLE 11.8.

Your Company manufactures a range of boys shirts which are sold directly to retail shops. The minimum order for any particular pattern is 10 shirts but in practice this has become the general level of most orders. As the cost accountant you have been asked to investigate the effect of increasing the minimum order to 20 shirts.

From the data given below you are required to :

Prepare a summary for management showing the following information per shirt :

Column 1 Selling price	Column 2 Profit	Column 3 Profit as a % of investment
---------------------------	--------------------	---

using the following bases :

- Current 'minimum 10' orders.
- proposed 'minimum 20' orders, assuming the present selling price is unchanged ;
- proposed 'minimum 20' orders, when the selling price is set to leave unchanged the present level per shirt of—
 - Profit ;
 - Profit as a % of total costs ;
 - Profit as a % investment ;
 - Contribution ;
 - Percentage mark-up on direct costs.

The current data per shirt for 'minimum 10' orders are :

	Rs.
Direct material cost	3.00
Direct wages cost and Direct charges	4.00
Direct selling cost	1.00
Apportioned overhead .	
Supervision	1.00
Depreciation	0.50
Interest charges	0.50
Investment	50.00

Profit amounts to 20% of selling price.

The effects of changing to 'minimum 20' orders are :

- * Reduction of 10% in material usage reflecting a more economical cutting pattern
- * Saving of 5% in wages cost due to less set-up time.
- * Average selling cost reduced by 25% when booking double-sized orders.
- * A 10% saving per shirt in supervisory cost.
- * Depreciation cost per shirt reduced by 10% resulting from better machine utilisation
- * A 20% reduction in interest charges due to less stock held to meet urgent orders.
- * Investment down by Rs. 10.00 per shirt as more stock is carried by retailers.

(I.C.W.A., Final)

ANSWER .

The data in respect of 'Minimum 10' and 'Minimum 20' after taking into account the effects of the changes may be tabulated as follows :

	Minimum 10 (Per shirt)	Minimum 20 (Per shirt)
	Rs	Rs.
Direct material cost	3.00	2.70
Direct wages and Direct charges	4.00	3.80
Direct selling cost	1.00	0.75
Variable cost	8.00	7.25
Fixed cost apportioned :		
Supervision	1.00	0.90
Depreciation	0.50	0.45
Interest	0.50	0.40
Total cost	10.00	9.00
Profit (20% of selling price - 25% of cost)	2.50	
Selling price	12.50	
Marginal contribution	4.50	
Investment	50.00	40.00

The desired information under the various proposed conditions are summarised below :

Base	Selling price	Profit	Profit as a % of investment
(a) Current 'Minimum 10' orders	12.50	2.50	5.00 (Investment = 50)
(b) 'Minimum 20' orders (Selling price unchanged)	12.50	3.50	8.75 (Investment = 40)
(c) 'Minimum 20' orders Selling price changed to retain the current levels of :			(Investment = 40)
(i) Profit	11.50	2.50	6.25
(ii) Profit % of total cost (i.e. 25%)	11.25	2.25	5.625
(iii) Profit % of investment (i.e. 5%)	11.00	2.00	5.00
(iv) Contribution (Rs. 4.50)	11.75	2.75	5.875
(v) Percentage mark up on direct cost i.e. $\frac{2.50}{8.00} \times 100 = 31.25\%$	11.27	2.27	5.675

(31.25% of 7.25)

Note : Figures in italics are the key figures making the changes in selling price.

EXAMINATION QUESTIONS

1. What is budgetary control? Discuss the various preliminaries required for adoption of a system of budgetary control. *(I.C.W.A., Final)*
2. A well-framed revenue budget is essential for the efficient control of costs. Discuss the procedure for introducing budgetary control in a newly established industrial enterprise. *(I.C.W.A., Final)*
3. Enumerate the duties and responsibilities of an Accountant who has been appointed a 'Budget Controller' of a large manufacturing concern.
State briefly the contents of a Budget Manual. *(I.C.W.A., Final)*
4. Explain the difference between a forecast and a budget. Give examples to illustrate the difference between :
(a) Fixed budget ;
(b) Flexible budget ;
(c) Functional budgets.
Do you consider that a business should ever budget for a loss on a year's trading? Give reasons for your opinion. *(I.C.M.A., Part IV)*
5. As an accountant of a company making, selling and distributing a wide range of products you are preparing to instal a system of budgetary control.
In a report to your managing director :
(a) state the factors to be taken into consideration in establishing the length of the proposed budget periods ;
(b) describe the operating of :
(i) a budgetary system for a given period, and also
(ii) a continuous budgetary system on a moving total basis.
In your report give the advantages and disadvantages of the continuous system compared with the period system
(c) state your recommendations on the level of attainment that should be adopted *(I.C.M.A., Pt. II)*
6. It is often suggested that the principal budget factor, or limiting factor is of vital significance to management. Explain this, and suggest what additional complications might arise where there is more than one limiting factor in a business. *(I.C.M.A., Final)*
7. As an Accountant of a concern manufacturing a wide range of products you have been asked to instal a system of budgetary control. While installing the system, state how would you deal with the following :
(a) Principal Budget Factor
(b) Length of the budget period, and
(c) Organisational set up for the control. *(I.C.W.A., Final)*
8. (a) Discuss the importance of the Principal Budget Factor in a system of budgetary control.
(b) Outline the methods of establishment of Sales budget and Production budget indicating clearly how the two budgets are co-ordinated when either Sales or Production is the principal budget factor. *(I.C.W.A., Final)*
9. What are the advantages of a Plant and Equipment Budget ? What factors would you take into account in including an item in the Plant and Equipment Budget? *(I.C.W.A., Final)*
10. Outline the steps necessary for the preparation of a detailed man-power estimate which would be of value in preparing a labour budget.
Compile a man-power estimate for a production department showing the break down to cost centres of the various grades of labour required. *(I.C.M.A., Final)*
11. A manufacturing company, operating a system of Budgetary Control finds that their production capacity during the year varies between 75% and 90% as against the budgeted capacity of 80% for the year. It has been suggested that a system of flexible budgets should be introduced to effectively control costs. Outline the steps you would take to implement this suggestion keeping in mind that the management would still require periodic comparison with their overall budget during this year. *(I.C.W.A., Final)*

12. It is sometimes argued that the flexible budgetary control approach to cost control within production departments is obsolete. The main arguments seem to be that :
 - (a) Production costs are tending to become more and more fixed policy costs, outside the control of departmental manager.
 - (b) Because of (a), there is no point in flexing the cost budgets for ultimate comparison with actual costs, and that this is a meaningless and wasteful exercise.
 - (c) This mechanistic form of control requires the involvement of managers in the setting of budgets, and this they can rarely do because of the absence of the necessary standard data.

Discuss these points separately and appraise the general argument.

(I.C.M.A., Pt. IV)
13. Budgetary control of repairs and maintenance is extremely difficult. Discuss.
14. "Cash Budget. This budget is the plan of the receipts and payments of cash for the budget period and for shorter terms, drawn up so that the balance can be forecast at regular intervals". (An introduction to Budgetary Control, I.C.M.A.)

Some accountants operating system of budgetary control claim that it is not necessary to draw up a cash budget. Explain what takes its place, and indicate how the probable cash position at any time is made available to management.

(I.C.M.A., Final)
15. In preparing a financial budget for a six month period, draft a columnar statement specifying the headings for the entries without entering any figures, to show the budgeted working capital at the end of each month. In addition, provide in the lower half of the statement for additions to and deduction from the budgeted figures to reflect monthly the changes in the plant.
16. What are the objects of drawing up a capital expenditure budget? When funds available for capital expansion are limited, what order of priority would you recommend for including capital expenditure proposals in the budget?
17. Set out, point by point, the purpose of and procedure for preparing an annual capital expenditure budget in a medium sized manufacturing company.
18. Discuss the concept of responsibility accounting and the role of the shop supervisor in controlling manufacturing costs.
19. The sales director of a manufacturing company reports that next year he expects to sell 50,000 units of a certain product.

The Production Manager consults the Store-keeper and costs the figures as follows :—

Two kinds of raw materials, A and B are required for manufacturing the products. Each unit of the product required 2 units of A and 3 units of B. The estimated opening balances at the commencement of the next year are :—

Finished product—10,000 units, A—12,000 units, B—15,000 units ; the desirable closing balances at the end of the next year are :

Finished product—14,000 units, A—13,000 units, B—16,000 units.

Draw up a quantitative chart showing the material purchases budget for the next year.

20. The newspaper industry works under conditions which have no bearing with other industries, especially for the preparation of a budget. Mention the conditions and keeping them in view, draw up the skeleton of a budget for a newspaper having a daily circulation of 60,000 copies.
21. The machine shop of an engineering concern comprises 150 machines, some special purpose, but mainly general purpose. The special purpose machines are used for the manufacture of certain standard components which are fitted to proprietary product of the organisation, though they are capable of being used on the jobbing production for which the general purpose machines are available. The jobbing production comprises small batches of parts for the automatic trade and general jobbing work on the customers' own materials.

Within the framework of a budgetary control system, you as a cost accountant are called upon to assist the new manager of the department in the construction of six monthly budgets. The Manager has no experience of budget setting. How would you deal with the problem? *(I.C.W.A., Final)*

22. PAC, a progressive enterprise manufacturing only two products and selling them under the brand names, Resina and Pipto, prepares every month, forecast of profit (or loss) and a budgeted cash flow statement for presentation to the managing Director. Each of the products requires only two types of raw materials in the following proportions .

	Resina	Pipto
	per unit	per unit
Material (1)	2 Kgs.	4 Kgs.
Material (2)	4 Kgs.	2 Kgs.

The direct labour hours for R and P are 4 and 6 per unit respectively. For the month of November, sales forecast were as follows .

Product	Units	Price per unit
Resina	3,000	Rs. 60
Pipto	6,000	Rs. 80

The opening inventory on 1st November and the proposed closing inventory on 30th November were :

	Opening Stock	Budgeted Closing Stock
Material (1)	4,000 Kgs	5,000 Kgs
Material (2)	2,500 Kgs	4,000 Kgs
Resina	200 units	250 units
Pipto	400 units	500 units

Standard cost data for the month of November were :

Material (1)	Rs. 2 per Kg
Material (2)	Rs. 4 per Kg
Direct labour	Rs. 4 per hour
Manufacturing overhead (application rate)	Rs. 2 per direct labour hour
Administration overhead	Rs. 20,000
Selling and Distribution overhead	Rs. 40,000

Sales are collected 50% in the month of sale and 25% in each of the next two months. Material (1) is purchased in cash but on Material (2), the suppliers allow a credit of one month, i.e. all payments are cleared in the following month. Wage calculations are ready by the first week of the next month and payment is made on the 9th and 10th. Relevant figures for the three months are extracted below :

	September Rs.	October Rs.	November Rs.
Sales	8,00,000	6,00,000	
Purchase : Material (2)		70,000	
Wages for the month		2,00,000	
Other net cash expenses			2,00,000 (Budgeted)
Opening balance of cash			20,000 (On 1st Nov.)

In addition to the above, advance tax estimated at 60% of the net profit in November was required to be paid in the month.

You are required to prepare the Production Budget, Material and Direct Labour Cost Budgets, Budgeted Profit/Loss Statement and Budgeted Cash Flow Statement for November. *(I.C.W.A., Final)*

23. As a cost accountant of Modern Manufacturing Company, you are asked to prepare quarterly production budget and direct materials purchase budget for the accounting year, 1st July, 1981 to 30th June, 1982.

The following information is relevant :

- (i) The Company manufactures only two products, A and B.

(ii) Sales volume forecast (in units)

1981—82	A	B
Quarter I	1,500	2,000
Quarter II	1,000	2,500
Quarter III	1,000	2,000
Quarter IV	1,500	2,500
1982—83		
Quarter I	1,500	2,500

(iii) Raw Materials requirement forecast :

The standard quantities of the two raw materials, X and Y, which should be used in the manufacture of the two products and the prices of these raw materials have been estimated as follows :

Standard quantities :

Raw material X—2 units for each unit of product A

Raw material Y—3 units for each unit of product B

Estimated costs :

Raw material X—Rs. 10 for each unit of X

Raw material Y—Rs. 6 for each unit of Y

Usage variance :

5% is provided to cover spoilage and scrap in case of material X and 4% in the case of material Y.

(iv) Stock forecasts :

Estimated opening stock :

Product A	750 units
Product B	1,250 units
Raw material X	1,575 units
Raw material Y	3,900 units

It is planned that closing stock level at the end of each quarter should be maintained at a level equal to half the expected sales for the next quarter for both the products and the raw materials stocks at the end of each quarter should be held accordingly. (I.C.W.A., Final)

24. Carryon Ltd. makes two products, A & B, and is in the process of formulating its budget for 1984. The Sales manager is confident that he would be able to sell 9,000 units of Product A at Rs. 60 per unit and 7,000 units of Product B at Rs. 85 per unit, or alternatively 12,000 units of Product A at Rs. 55 per unit and 5,000 units of Product B at Rs. 90 per unit.

(i) Direct material and labour at expected actual rates and quantities per unit of output are :—

Materials	Rate	Product A	Product B
X	Rs. 3 per Kg.	2 Kg.	3 Kg.
Y	Rs. 1 per metre	5 metres	6 metres
Labour			
Department 1	Rs. 4 per hour	6 hrs.	—
Department 2	Rs. 2.50 per hour	—	10 hrs.

(ii) Opening Stock

Material X	3,000 kg.
Material Y	4,080 metres
Product A	1,000 units
Product B	350 units

(iii) Estimated Closing Stocks :

Material X	3,600 kg.
Material Y	5,400 metres
Product A	1,250 units
Product B	500 units

- (iv) Flexible Budget for Departmental Overheads in 1984 (Assume no fixed element) : —

Direct Man Hours	Dept. 1 Rs.	Dept 2 Rs.
45,000	80,000	55,000
50,000	1,00,000	80,000
55,000	1,20,000	1,00,000
60,000	1,45,000	1,15,000
65,000	1,75,000	1,25,000
70,000	2,10,000	1,30,000
75,000	2,50,000	1,35,000

- (v) Production, Selling and other general administration overhead Fixed Cost Rs. 1,20,000.
 (vi) Selling variable cost of Rs. 2 per unit of sales of A or B
 (vii) Other relevant data :
 (a) Work-in-Progress is nil at the beginning and end of the Budget period
 (b) Assume an even flow of production throughout 1984
 (c) Finished Stock is valued at Prime Cost.
 (d) A man employed works at 45 hour week for 50 weeks of the year with two weeks paid holiday

You are required to prepare

- (i) The Sales Budget, the Cost of Sales and the separate contributions to profits of each product separately under each of the alternative Sales Budgets
 (ii) Select from the alternative income account the one to be preferred and compute the net profit in total of that combination and prepare in physical and monetary terms the following schedules in respect of the selected Budget
 (a) Raw material purchases,
 (b) Direct labour,
 (c) Production.

25 The Profitability statement of G Co. Ltd has been summarised as given below

	Rs.	(I.C.W.A., Final) Rs.
Sales		15,00,000
Direct material	4,50,000	
Direct Wages	3,00,000	
Variable Overheads	1,20,000	
Fixed Overheads	4,40,000	13,10,000
Profit		<u>1,90,000</u>

The budgeted capacity of the Company is Rs. 20,00,000 but the key factor is sales demand. It is proposed that in order to utilise the existing capacity the selling price of the only product manufactured by the company should be reduced by 5%.

You are requested to prepare a forecast statement which should show the effect of the proposed reduction in selling price and include any changes in costs expected during the coming year. The following additional information is given

- (i) Sales forecast Rs. 19,00,000 (after reduction)
 (ii) Direct material prices are expected to increase by 2%
 (iii) Direct wage rates are expected to increase by 5% per unit
 (iv) Variable overheads are expected to increase by 5% per unit
 (v) Fixed overhead will increase by Rs. 20,000.

(I.C.W.A., Final)

26. A manufacturing company has prepared a Budget for the year ended 31st December, 1984. Using the relevant data given below, prepare a cash budget for each of the months of February, March and April, 1984

Estimated variable cost per unit :

	Rs.
Direct material	3
Direct wages	4
Production overhead	2
Total	<u>9</u>

CHAPTER 12

STANDARD COSTING

Limitation of Historical Costs. Costs are classified as to the time or method of computation, into historical costs and predetermined costs.

Historical costs are 'postmortem' costs ascertained after they have been incurred and they represent the cost of actual operational performance. Actual performance is evaluated by comparing the historical cost with predetermined cost norms.

In a decision making process, historical data are required for predicting future costs of the various alternative actions under consideration. When one of these alternatives is selected as the best line of action and the decision is implemented, the feed back mechanism generates historical data relating to the operation evaluation. This completes the *historical data cycle*.

Predetermined costs are future costs computed in advance of production, on the basis of a specification of all the factors affecting cost. Predetermined costs may be either estimated or standard.

During the first stages of development of cost accounting, historical costing was the only method available for ascertaining and presenting costs. Historical costs have, however, the following limitations :--

- (a) Historical cost is valid only for one accounting period during which the particular manufacturing operation took place. The cost information obtained after completion of the job, process, or service—sometimes long after it—is of no practical utility for control purpose.
- (b) Data is obtained too late for price quotations and production planning.
- (c) Historical cost relating to one batch or lot of production is not a true guide for fixing price. Wide fluctuations in the costs of various batches make historical costing non-typical and so, even average historical costs over a number of periods are not useful for setting sales prices.
- (d) Past actuals are affected by the level of working efficiencies. Actual costs may be inflated due to inclusion of abnormal expenses, avoidable wastes and rejections, ineffective use of labour, and use of excessive quantities of materials. Further, material prices, wage rates, and overhead absorption rates might have undergone a change in the current period. Historical cost is not a proper yardstick and is, therefore, ineffective as a means of measuring performance efficiency.
- (e) Historical costing is comparatively expensive as it involves the maintenance of a large volume of records and forms.

These limitations and disadvantages attached to historical costing system led to further thinking on the subject and resulted in the emergence of standard costing which makes use of scientifically pre-determined standard costs under each element, viz. labour, material and overhead. The need for cost accounting which adopts the standard costing technique is now accepted in almost all industries.

General Principles of Standard Costing. Standard costing is defined as the preparation and use of standard costs, their comparison with actual costs and the measurement and analysis of variances to their causes and points of incidence. Standard cost is a predetermined cost that is calculated from the management's standards of efficient operation and the relevant necessary expenditure. Standard costs are useful for cost estimation and price quotation and for indicating the suitable cost allowances for products, processes and operations but they are effective as tools for control only when compared with the actual costs of operation. The techniques of standard costing may be summarised as follows : --

- (i) Predetermination of technical data related to production, i.e. details of materials and labour operations required for each product, the quantum of inevitable losses, efficiencies expected, level of activity, etc.
- (ii) Predetermination of standard costs in full details under each element of cost, viz. labour, material, and overhead.
- (iii) Comparison of the actual performance and costs with the standards and working out the variances, i.e. the difference between the actuals and the standards.
- (iv) Analysis of the variances in order to determine the reasons for deviations of actuals from the standards.
- (v) Presentation of information to the appropriate level of management to enable suitable action (remedial measures or revision of the standard) being taken.

Standard costing is not a distinct system of accounting but is only a technique that can be applied to all types of costing, such as job costing or process costing. Maximum benefit from standard costing system is obtained in industries producing standardised products which are repetitive in nature, so that realistic attainable standard costs can be fixed with ease. But even in concerns doing non-repetitive work of the jobbing type, e.g. manufacture of automobiles, ships, engines, boilers etc., the principles of standard costing may be applied ; there would always be certain departments, processes, or operations for which standards can be set and the system of standard costing can be introduced. For example, it would not be difficult to determine labour time or operational standards for such activities as milling, grinding, drilling, planning, trimming, shaping etc., which are common operations for many jobs.

Standard Costing and Budgetary Control. Like budgetary control, standard costing assumes that costs are controllable along definite lines of supervision and responsibility, and it aims at managerial control by comparison of actual performances with suitable predetermined yardsticks. The basic principles of cost control, viz. setting up of targets or standards, measurement of performance, comparison of actuals with the targets, and analysis and reporting of variances are common to both standard costing and budgetary control systems. Both techniques are of importance in their respective fields and are complementary to each other. Thus conceptually there is not much of a difference between standard costs and budgets and the terms budgeted performance and standard performance mean, for many concerns, one and the same thing.

Budgets are usually based on past costs adjusted for anticipated future changes but standard costs are of help in the preparation of production costs budgets. In fact, standards are often indispensable in the establishment of budgets.

On the other hand, while setting standard overhead rates for standard costing purposes, the budgets framed for the overhead costs may be made use of with modifications if necessary. Thus, standard costs and budgets are inter-related though not inter-dependent.

Despite the similarity in the basic principles of standard costing and budgetary control, the two systems vary in scope and in the matter of detailed technique. The differences may be summarised as follows :—

- (i) A system of budgetary control may be operated even if no standard costing system is in use in the concern.
- (ii) While standard is a unit concept, budget is a total concept. We say that standard direct labour cost is Rs. 4 per unit but when we talk about the budgeted labour cost, we usually express it in total as say, Rs. 40,000 (supposing 1,000 units are produced).
- (iii) The purposes of standards and budgets are different. Budgets are anticipated or expected costs meant to be used for forecasting requirements of finance, labour, material, etc. Standard costs are assumed or planned costs under specific assumed conditions of production performance, capacity level, and operation and as such, they cannot always be used for the purpose of forecasting.
- (iv) Budgets are the ceilings or limits of expenses above which the actual expenditure should not normally rise; if it does, the planned profits will be reduced. Standards are minimum targets to be attained by actual performance at specified efficiency. The planned objective is achieved if the target is reached and profits increase if it is surpassed. Thus, while budgetary control lays emphasis on costs not exceeding the budgets, standard costing gives importance to cost approaching the standard.
- (v) Budgets are complete inasmuch as they are framed for all the activities and functions of a concern such as production, purchase, selling and distribution, research and development, capital utilisation, etc. Standard costing relates mainly to the function of production and the related manufacturing cost. Moreover, budgets include both income and expenditure whereas standards are usually for expenditure only.
- (vi) A more searching analysis of the variances from standards is necessary than in the case of variations from the budget. Costs within the budget merely indicate efficiency already achieved and no further analysis is necessary. If expenditure exceeds the budget, it simply gives information about a bad situation, but variances from standards provide material for further probe and a detailed analysis is needed to find channels of economy.
- (vii) Budgets are indices, adherence to which keeps a business out of difficulties. Standards are pointers to further possible improvements.

Standard Costs and Estimated Costs. The distinction between standard costs and estimated costs should be clearly understood. While both standard costs and estimated costs are predetermined costs, their objectives are different. The main differences between the two types of costs are—

- (i) Estimated costs are intended to determine what the costs 'will' be. Standard costs aim at what costs 'should' be.

- (ii) Estimated costs are based on average of past actual figures adjusted for anticipated changes in future. Anticipated wastes, spoilages, and inefficiencies, all of which tend to increase costs, are included in estimated costs. Standard costs are planned costs determined on a scientific basis and they are based upon certain assumed conditions of efficiency and other factors.
- (iii) In estimated costing systems, stress is not so much on cost control, but costs are used for other purposes such as fixation of prices to be quoted in advance. Standard costs serve as effective tools for cost control.

Advantages of Standard Costing. The advantages derived from a system of standard costing are tabulated below :

- (i) Standard costing system establishes yard-sticks against which the efficiency or inefficiency of actual performances are measured. This facilitates control and infuses cost consciousness among the executives. It also promotes co-operation and co-ordination amongst the various functions and departments of the concern.
- (ii) The standards provide incentive and motivation to work with greater effort and vigilance for achieving the standard. This increases efficiency and productivity all round.
- (iii) At the very stage of setting the standards, simplification and standardisation of products, methods, and operations are effected and waste of time and materials is eliminated. This assists in managerial planning for efficient operation and benefits all the divisions of the concern.
- (iv) Costing procedure is simplified. There is a reduction in paper work in accounting and less number of forms and records are required. There is considerable saving in clerical time and expenditure leading to reduction in the cost of the costing system.
- (v) Costs are available with promptitude for various purposes like fixation of selling prices, pricing of inter-departmental transfers, ascertaining the value of closing stocks of work-in-progress and finished stock, and determining idle capacity. Standard costing provides reliable, accurate, and firm data with simplicity and ease, for the purpose of pricing and filling in tenders and offering quotations. Once prices are fixed, no further adjustments and revisions are necessary as would be required in the case of historical costing.
- (vi) Standard costing system facilitates delegation of authority and fixation of responsibility for each department or individual. This also tones up the general organisation of the concern.
- (vii) Standard costing is an exercise in planning—it can be very easily fitted into and used for budgetary planning.
- (viii) Variance analysis and reporting is based on the principles of *management by exception*. The top management may not be interested in details of actual performances but only in the variances from the

standards, so that corrective measures may be taken in time. This is all the more useful in large organisations where attention may be focussed on out-of-control or out-of-line situations, which normally the busy top executives may not otherwise be aware of.

- (ix) When constantly reviewed, the standards provide means for achieving cost reduction. Focus on out-of-control situations leads to cost reduction through improved methods, improved quality of products, better materials and men, effective selection and use of capital resources, etc.
- (x) Standard costs assist in performance analysis by providing ready means for preparation and interpretation of information.
- (xi) Production and pricing policies may be formulated in advance before production starts. This helps in prompt decision making.
- (xii) Standard costing facilitates the integration of accounts so that reconciliation between cost accounts and financial accounts may be eliminated.
- (xiii) Standard costing optimises the use of plant facilities, current assets, and working capital.

Limitations of Standard Costing. Standard costing has certain limitations. These are :

- (i) Establishment of standard costs is difficult in practice. Even if the particular type of standard to be used has been properly defined, there is no guarantee that the standard established will have the same tightness or looseness as envisaged, throughout the organisation.
- (ii) In course of time sometimes even in a short period—the standards become rigid. It is not always possible to change standards to keep pace with the frequent changes in the manufacturing conditions. Revision of standards is costly and creates problems so that some firms simply ignore such revision.
- (iii) Inaccurate, unreliable, and out of date standards do more harm than benefit.
- (iv) Sometimes, standards create adverse psychological effects. If the standard is set at a high level, its non-achievement results in frustration and a build-up of resistance. This acts as a discouragement rather than an incentive for better efficiency.
- (v) Due to the play of random factors, variances cannot sometimes be properly explained, and it is difficult to distinguish between controllable and non-controllable variances. For example, the responsibility for an adverse labour time variance may not be fixed on the production department because such a variance may be due to causes beyond their control, such as poor grade of labour (which is the responsibility of personnel department), poor quality of material (purchase department or inspection department), defective plant and machinery (maintenance department), and lack of trained workers or poor working conditions (top management).
- (vi) Standard costing may not sometimes be suitable for some small concerns. Where production cannot be carefully scheduled, frequent

changes in production conditions result in variances, detailed analysis of all of which would be meaningless, superfluous, and costly. A worker in a small business may, for instance, operate several machines under different conditions and at times he may be called upon to set up a machine or to handle raw materials to feed the machines, or sometimes during his temporary absence, his machine may be operated by his supervisor or the chargehand. The variances arising under such circumstances are already known to the management and any elaborate arrangements to analyse them would, therefore, be unnecessary. Thus, in small concerns personal contacts may be more effective than a system of standard costing.

- (vi) Standard costing may be found to be unsuitable and costly in the case of industries dealing with non-standardised products and for repair jobs which keep on changing in accordance with customers' specifications. Where products take more than one accounting period for completion, standards may not be very effective.
- (viii) Lack of interest in standard costing on the part of the management makes the system practically ineffective. This limitation, of course, applies equally in the case of any other system which the management does not accept whole-heartedly.

Setting of Standard Costs. The first step in the development of a standard costing system is to set standard costs, i.e. to predetermine the standards in respect of each element of cost—direct material, direct labour, and overhead. Extreme care is essential in the fixation of standards as the success of a standard costing system depends largely upon the accuracy of the standard costs used.

While setting production costs standards, the following *preliminaries* should be considered :—

- (a) Study of the technical and operational aspects of the concern, such as methods of manufacture and the processes involved, management organisation and line of assignment of responsibilities, division of the organisation into cost centres, units of measurement of input and output, anticipation of wastes, rejections and losses, expected efficiency, and capacity likely to be utilized.
- (b) Review of the existing costing system and the cost records and forms in use.
- (c) The type of standard to be used, i.e. whether current, basic, or normal standard costs are to be set. (The various types of standards in use are discussed in the following section.) The choice of a particular type of standard will depend upon two factors, viz. which type would be most effective for cost control in the organisation, and whether the standards will be merged in the accounting system or kept outside the accounts as statistical data.
- (d) Proper classification of the accounts so that variances may be determined in the manner desired.
- (e) Fixation of responsibility for setting standards. As definite responsibility for variances from standards is ultimately to be laid on individuals or departments, it is but natural that all those individuals or departments

should be associated with the setting of standards. A *Standards committee* or a *Standards division* in which the purchase manager, personnel manager, and production manager are represented, is constituted on the lines of the budget committee. The cost accountant co-ordinates the functions of the standards committee.

Types of Standard Costs. While it is accepted that standard costs are what the costs should be under a particular set of circumstances, there is divergence of opinion as to what should be the circumstances or conditions which should be taken as the basis for setting of the standard costs. Based on this difference of opinion, there are several types of standard costs in use. Standards may be classified according to :

- (i) Length of period of use- *current standard* and *basic standard* ;
- (ii) Standard of attainment, i.e. performance level --*ideal standard*, *normal standard*, *expected standard*, *historical standard*, *current or expected actual standard*, and *basic or bogey standard* ,
- (iii) Price level --*ideal standard*, *normal standard*, *current standard*, and *basic standard* ; and
- (iv) Output level --*theoretical standard*, *practical standard*, *normal standard*, and *expected standard*.

Current standards : Current standards are established for use over a short period of time and they reflect what the performance ought to be under current conditions, i.e. during the period in which the standards are to be used. The current conditions are subject to alterations if there is, say, any change in the method of production or in the price level. In order to keep pace with these changes, current standards require periodical revision and in view of such frequent revisions, current standards may be valid only for the accounting period under consideration.

Basic standards : These are also known as *bogey standards*, *fixed standards*, or *static standards*. Basic standards are established for use unaltered, over a long period of time and thus, they may not always reflect the current conditions. They are not useful for cost control as they do not indicate what level of efficiency should be attained. Basic standards are, therefore, seldom used except in industries where the technical processes or operations are fully established and do not materially change over a number of years. These standards may, at best, serve as standards of measurements and are not meant to reflect price or rate changes. Under the basic standard system, standard costs and actual costs are recorded side by side and the variances which show trends are indicated in monetary terms as well as in percentages. The percentage which the actual cost bears to the basic standard cost is compared with the percentage of the current standard cost to basic standard cost. A comparison of the percentages with those of past periods shows the trends of movement of actual and current standard costs from the basic standard cost.

Normal standards : These are the average standards which, it is anticipated, can be attained over a future period of time, preferably long enough to cover one trade cycle. For example, if the normal trade cycle in an industry is six years which would consist of boom and slack periods, standard costs may be based on the average conditions during these six years. The difficulties involved in making correct forecasts in most businesses over a long period limit the scope of normal

standard costs for cost control purposes and for taking short-term decisions. The main advantage, however, is that normal standards do not need adjustments and are useful in long-term planning and decision making.

Depending upon the level of performance efficiency at which a standard is set, it may be either an (a) ideal standard or (b) expected standard.

- (a) *Ideal standard* : This is the standard which may be attained under the most favourable conditions possible. An ideal standard is very tight and calls for a high degree of efficiency and performance that would be unattainable under normal circumstances. Ideal standard is based on the minimum quantity of material at the lowest price, labour at minimum rate and time, and overhead at maximum efficiency.

In practice, it is rather impossible to reach up to such a standard and as such, whenever ideal standards are used, the accounts reveal unfavourable variances as a permanent feature. Ideal standards are, therefore, mainly theoretical and their non-achievement causes frustration amongst the staff. Cost analysis reports which always show unfavourable variances are taken for granted and their impact on the management is lost, so that from the cost control point of view, ideal standards are not of much use. Another disadvantage is that due to the almost permanently occurring adverse variances, the inventory at standard cost is always under-valued and the profits are distorted.

Ideal standards possess the advantage that they can be used for relatively long periods without any adjustment. They may be useful in limited spheres. In a factory or in a particular section of a factory, where say, automatic machines are in use and efficient methods of production and production control exist, ideal standards may be most suitable.

- (b) *Expected or Attainable Standard* : This is the standard which can be attained during a future specified budget period, if a standard unit of work is carried out efficiently, a machine properly operated or material properly used. Expected standard costs take into account the conditions and circumstances which would prevail during the period for which the standard is set. Normal allowances in regard to labour time wastage, excess usage of materials, machine break downs, etc. are provided for. Compared to ideal standards, expected standards are more realistic and more motivating. The analysis of the variances is useful from the cost control point of view as variances from the expected standard reveal real deviations from anticipated performance efficiency.

Standard Costs for Direct Materials. Setting of standard costs for direct materials involves two basic processes, viz. (i) fixation of standard material quantity, i.e. the *material usage or utilisation standard*, and (ii) expressing it in monetary terms with reference to the price of the materials so as to set *material price standard*. A pre-requisite to the accurate setting of material standards is that the organisation should have a system of efficient materials control covering purchases, receipt, inspection, storage, drawal, and physical verification of materials.

- (i) *Material utilisation standard* : The quality and size of the various items of materials required for production are first standardised and then the quantity of each item of materials is determined with regard to weight,

size etc. of each unit of the finished product. The standard quantities of material are developed by the technical or production departments, drawing office, or laboratory. This is done consistent with the design and quality of the products, after what is known as *Product study* or *Engineering study* which goes into the details of the materials and plant conditions. The quality and quantity of the standard materials may also be developed by trial or sample runs or by study of past data. The material requirements are set at the minimum so as to achieve maximum economy in material usage. The materials, particularly substitute materials are specified keeping in view their cost and quality. The standards should cover not only raw materials but also purchased parts, components, etc.

The standard materials along with the standard quantities of each are noted in a list called *Standard material specification or standard bill of materials*.

While setting the standards, allowances should be made for normal unavoidable losses, scrap, and wastage occurring at the various stages of manufacture. The minimum standard losses on account of evaporation, breakage, cutting etc. should be pre-determined and taken into account. The allowances are fixed with utmost care as a high allowance will conceal inefficiencies in usage while a low allowance which would result in unfavourable variances may lead to wrong conclusions. Abnormal losses of material occurring during storage should not be included in the material usage standard.

In processing factories where different kinds of raw material are mixed or blended for a process, a standard material mix is established for managerial control purpose. In those processes where the raw material input changes its form and is processed into the output in a different form, standard yield percentage may be set. The yield is determined as follows :

$$\text{Percentage Yield} = \frac{\text{Quantity of good output produced}}{\text{Quantity of input consumed}} \times 100$$

- (ii) **Material price standard** : Standard price for each item of material is fixed by carefully studying the price and market conditions and forecasting the trend of prices for a definite future period. The value of stock in hand and the future purchases already contracted should also be taken into account. The idea is that the standard price should be as realistic as possible and should conform to the market trends during the period for which the standards remain in force. The purchase department that is finally responsible for any variances from the standards should be closely associated with the setting of material price standards.

The standard price of materials should take into account not only the price but also discounts and other allowances and rebates, packing and delivery charges, mode of delivery, insurance coverage, etc. The methods of treatment of other related material costs like receipt, inspection, handling and upkeep, and issues expenses vary from one concern to the other. These costs if taken as part of the direct material cost, should be included in the standard for direct materials.

Material price standards may be based on current (attainable normal) or on basic (fixed) price. The current price standard is normally used for a year and conforms to the expected actual cost. It, therefore, serves as a measure of efficiency of the purchase department. Normal price standards are the average of the prices over a number of years allowing for seasonal variations. Since fixed price standards are used almost permanently and are not subject to revision, the variances from such standards merely indicate the trend. The particular type of price standard selected will depend upon management policy and requirement of the situation. When market prices fluctuate violently, establishment of price standards presents difficulties. The standard may be fixed on the basis of the average past market price during a complete business cycle. Alternatively, the average of the expected prices during the period the standard remains valid is established as the standard.

Standard Costs for Direct Labour. As in the case of direct material standards, development of direct labour standards consists of two phases, viz. (i) fixation of labour time (i.e. quantity) and (ii) setting of the labour rate (i.e. price) standards for each product manufactured. The standard time for each operation multiplied by the standard labour rate gives the standard labour for the operation.

An analysis of the labour operations to be performed on a product precedes the setting up of direct labour standards. The technique of work study is helpful in this respect. Each item of manufacture is studied in detail to find out the various labour operations to be performed, plant, machinery, and tools required, the departments in which the various operations are to be carried out, the different grades of labour to be employed, and the standard time for performance and the rate payable for each operation.

- (i) *Labour time standards* : The labour time of standard performance required for the various operations on a product is determined. This may be done in any of the three ways :
 - (a) *Using past records of performance* : Though this is a simple method, it is not scientific.
 - (b) *Time and motion study* : Usually the average worker's time, after time and motion study, is taken as the standard. The standard time should take into account all time on account of waste, fatigue, tooling, and other contingencies.
 - (c) *Taking trial runs* : This is sometimes used for fixing labour time for new products when test or pilot runs for small batches of production are made. The method is, however, not satisfactory as real conditions are not available in such runs.
- (ii) *Labour rate standards* : For the fixation of labour rate standards, the operations to be performed, the grades of labour required to perform the various operations, and the rates of pay expected to be paid to the labour should be taken into consideration. Where piece-work system of payment is in vogue, the setting of rate standards is simple because the piece-rate correctly fixed would itself form the standard rate. In the case of day work system, an average hourly rate of pay is fixed for each grade of workers with reference to the standard labour rate. Data

regarding rates paid in the past may not be an appropriate guide if the labour rates are subject to the fluctuating demand and supply of the labour force. In such cases, a fairly accurate and reliable forecast of the rate likely to prevail during the period in which the standard will be in force, is essential. In many of the industries, however, where wage rates have been fairly stabilized by contracts, Acts and Laws, Wage Tribunals, or Wage Boards, setting of standard labour rates does not present any problem. When bonus or premium plans of wage payment are in use, it is a matter of opinion whether or not the bonus or premium paid should be included in the standard labour rates. If it is decided to include them, the average of the past payments adjusted to current requirements is added to the labour operation rate. If past records of performance are not available, the rate adopted will depend upon the expectation as to what an average worker is likely to earn under the plan.

Standards for Overhead Costs. Fixation of overhead standard involves, (i) determination of standard overheads costs, (ii) estimation of production, i.e. the standard level of activity reduced to a common base such as direct labour hours, machine hours, direct labour cost, units of production, etc. and (iii) determination of the standard overhead rate. The formula for the standard overhead rate is :

$$\text{Standard overhead rate} = \frac{\text{Standard overhead for budget period}}{\text{Standard base for the budget period}}$$

Setting of standard overhead rates is a much more complicated exercise than the establishment of material and labour standards. The process may, however, be simplified if a system of budgetary control is in vogue. As stated previously, the budgeted overhead costs represent expenses that "will be" incurred but standard costs relate to expenses that "should be" incurred. For the purpose of determining the standard overhead rates, the budgeted overhead costs are suitably modified so as to constitute what the overhead costs "should be". Similarly, the denominator in the above formula, i.e. the standard base or production factor is obtained by adjusting and revising the budgeted production to conform to what the production should be. Standard production may be linked with one of the following activity levels :

- (a) Maximum theoretical capacity (Ideal standard) ;
- (b) Practical operating capacity, i.e. the maximum capacity less allowances for normal idle time, breakdowns, and other inevitable interruptions (Attainable standard) ;
- (c) Normal capacity representing (i) the average conditions of production during a long period of business cycle (standard based on average of past periods), or (ii) the production based on the sales expected during the budget period (standard based on expected level of activity).

The numerator in the formula for the standard overhead rate, viz. the expenses may be classified into fixed, variable, and semi-variable. Each item of the budgeted variable and semi-variable expenses is analysed and standard

amounts set on the basis of what the item of cost "should be". So far as the fixed costs are concerned, these are largely uncontrollable at lower levels of management. The budgeted fixed cost is taken as the standard figure because there would be no difference between the "should be" and the anticipated costs.

After having set the standard overhead cost and the standard production, a simple process of division determines the standard overhead rate. Standard rates are set separately for fixed and variable overheads and for each production department or cost centre unless a blanket rate is in use.

Standard Cost Sheets or Standard Cost Cards. As stated earlier, the standards for each product or process etc. are maintained in Standard Bills of Materials and Standard Operations Sheets. These together with standard material prices and standard wage rates are recorded in a Standard Cost Sheet or Standard Cost Card. One cost sheet is maintained for each product manufactured. The cost sheet shows for a specified unit of product, the various types of materials to be used, the standard quantity, price, and total cost of each item of direct materials, the various operations the product would pass through, and the standard time, rate, and total direct labour cost of each operation. The standard rate and cost of factory overhead are also often included in the standard cost sheet. Illustrations of standard cost sheets, one suitable for concerns having process costing and the other for job costing concerns, may be seen in Figs. 12.1 and 12.2 respectively.

STANDARD COST SHEET									
Product :				Date of fixation of the Standard .					
Units :									
Materials			Process/ Department	Labour			Overhead		
Standard Quantity	Standard Price per unit	Standard Cost		Standard hours	Standard rate per unit	Standard Cost	Standard unit	Standard Cost	
A			1						
B			2						
C			3						
D									
Total Materials				Total Labour			Total Overhead		
Summary Material Labour Overhead Total manufacturing cost Standard cost per unit									

Fig. 12.1. Standard Cost Sheet (Process Cost)

STANDARD COST SHEET									
Product Standard units				Date of fixation of the Standard					
Materials				Department					
Item/ Code	Standard quantity	Standard unit price	Standard cost	1	2	3	4	Total	
1									
2									
3									
4									
Total materials cost									
Labour				Department					
Operation Number	Grade of worker	Standard hours	Standard rate per hour	Standard cost	1	2	3	4	Total
a									
b									
a									
b									
c									
d									
Total labour cost									
Overhead				Department					
Standard hours	Direct labour or machine hour rate	Standard cost	1	2	3	4	Total		
Total overhead cost									
Total standard cost									
Standard cost per unit									

Fig. 12.2. Standard Cost Sheet (Job Cost)

Standard Cost Periods and Revision of Standards. Standard cost may be established for a period of three, six or twelve months, or for that matter for any period. There is no definite rule or procedure for selecting a particular period and each case is decided according to the circumstances obtaining in the business and the type of standard required to be established. During periods of inflation, the utility of standard costs particularly standard material costs has been questioned and in order to meet such criticism, some firms change the standard costs every month. Such standards fixed on short run basis are, however, expensive, and frequent revisions of standards at short intervals impair their utility and defeat the purpose for which standards are set. An annual period may be more realistic as it coincides with the normal accounting period. Periods longer than one year have the advantage of saving in clerical costs and continuity and uniformity in standard costs which would show trends over long period. A high degree of flexibility in the procedure is, however, necessary so that the long-term standards may be adjusted to suit current conditions. Where the techniques of production have been fully established at the optimum level and material prices and wage rate levels are not likely to fluctuate appreciably, standard costs may be established for indefinitely long periods.

Standard cost is the resultant effect of a number of factors that vary from time to time in different situations, both internal and external. With changing conditions, a standard may become unrealistic, requiring revision. While it is essential to revise standard costs as and when necessary, too frequent a revision takes away the effectiveness of the system, increases clerical costs, and creates several other problems. Application of out dated standards is like using a wrong physical measure, say, weighing materials with a weight which does not conform to the standard kilogram, but changing of standards too frequently is like using an elastic kilogram which keeps on changing from time to time. Revision of standards should, therefore, be given as much thought and care as is essential for establishment of new standards.

Current standards are subjected to review, usually once a year, at the time when budgets are being established. They may be revised under the following circumstances : -

- (a) Errors in setting the standards.
- (b) Change in price level, e.g. revision of labour rates due to awards, increased local rates and taxes, and increased unit rates of purchase of services like electricity, gas, steam, etc.
- (c) Change in methods of production.
- (d) Change in the specifications or designs of products which require more or less material or labour time or the use of different material or grade of labour.
- (e) Technological advances.

Basic standards are more or less on a permanent footing so that their revision is necessary only under special circumstances, such as :

- (a) change in method of production or permanent change in specifications or designs of products,
- (b) change in plant capacity, or
- (c) the variation of actual performance from the standard becoming so large as to be of no real use.

Computation and Analysis of Variances. After the establishment of standard costs, the next step in the operation of a standard costing system is to ascertain the actual costs under each element and compare them with the standard set. The difference between the standard cost (or the budgeted cost if budgets and not standard costs are being considered) and the comparable actual cost incurred during a period is termed as *cost variance*. When the actual cost is less than the standard cost, this indicates efficiency and the difference is known as a favourable variance. Actual cost higher than the standard cost would be a sign of inefficiency and the difference would be termed as unfavourable or adverse variance. The terms 'favourable' and 'unfavourable' are used in a technical sense and they do not always convey the meaning in the ordinary sense. As we shall see later, an unfavourable variance may not sometimes indicate any real adverse effect on the economy of the business. Similarly, a favourable variance may not always have a favourable impact on the overall profitability of a concern.

Variances are computed under each element of cost for which standards have been established. As the ascertainment of variance is not in itself control, each of these variances is analysed to find out the causes or circumstances leading to it so that the management can exercise proper control. A suitable analysis will reveal that some of the variances are controllable while others are not so. If material is used in excess of the standard quantity, or the time taken by an operative exceeds the standard time set, responsibility for the unfavourable variances may be fixed on the executive concerned. Such variances would, therefore, be controllable. On the other hand, if variances arise due to extraneous causes such as labour disputes, general increase of wages rate in a particular trade, devaluation of currency, and variation in customer's demand, no responsibility can be assigned to any individual. Such variances would, therefore, be non-controllable. In most cases however, the line between controllable and non-controllable variance would not be sharp, and too rigid a distinction should not, therefore, be attempted. The purpose of classifying variances into controllable and uncontrollable is mainly to segregate the two so that proper emphasis may be placed on the controllable variance. This follows the principle of management control through exception. In fact, the entire procedure of variance reporting is based on this principle. Stress is laid on variances only and no action is necessary when actual costs are in conformity with the standard costs, provided that the conditions at which standard costs are fixed remain unchanged. Thus, the expenditure need not be controlled in its entirety.

Variances occurring in a period may be compared with variances on the same account for the previous period. The variance may be expressed as a percentage of the standard cost and compared with the percentage for the previous month. Comparison may be made between the standard and actual (in the manner shown below) or between basic standard and current standard.

	July '88	August '88
<i>Direct Material</i>		
Standard cost	Rs. 20,000	Rs. 20,000
Actual cost	Rs. 25,000	Rs. 25,600
<i>Variance</i>		
Amount	Rs. 5,000	Rs. 5,600
Percent of standard	25%	28%

The above method of presenting variances gives an index of performance. It is simple to calculate and easy to express, but it does not give a detailed analysis to enable management to exercise control over the variance. It is not enough to know that variances have occurred in different degrees from month to month. The origin and causes of the variances need be traced in order to take steps to reduce them. For this purpose, an analysis of the total variance should be made. Analysis of variances consists of resolving the total variances into their component parts in order to determine and isolate the causes giving rise to each variance, and reporting to the management those situations which need to be corrected or controlled. A detailed probe into the variances, particularly the controllable variances, helps the management to ascertain, (i) the amount of a variance, (ii) the causes for its occurrence, (iii) the factors responsible for it, (iv) the responsibility to be laid on executives and departments, and (v) corrective actions which should be taken to eliminate or reduce the variance. Equal emphasis should be laid on favourable and unfavourable variances. An unfavourable variance indicates that there has been some inefficiency and waste in the use of materials, labour, and resources, which require to be set right. A favourable variance may indicate an incorrect or out of date standard which needs revision. It may also arise due to some real improvement in performance efficiency, or due to manufacture of sub-standard products. Adoption of some short cut methods which effect long run costs also results in a favourable variance.

The efficacy of detailed analysis of variances will be apparent from an example. In a case where there is no variance in material costs, the actual material cost is the same as the standard cost, and apparently no action is called for. A further analysis may, however, reveal that there was actually an unfavourable price variance due to the inefficiency of the purchase department which was compensated by a favourable variance of the same amount due to economy in material usage.

In the sections that follow, variances are discussed under each element of cost.

Direct Materials Cost Variance. Direct materials cost variance is the difference between the actual direct material cost incurred and the standard direct material cost specified for the production achieved. Materials cost variances arise due to variation in the price of the material or in its usage. In accordance with the above, direct materials cost variances may be analysed under two heads (or sub-variances), viz. direct materials price variance and direct materials usage variance.

(a) *Direct materials price variance* : This is that portion of the materials cost variance which is due to the difference between the actual and standard price per unit of the material applied to the actual quantity of material purchased or used. The formula for calculation of this variance is :

$$\begin{aligned} \text{Direct materials price variance} &= (\text{Actual price} \text{ minus } \text{Standard price}) \\ &\quad \times \text{Actual quantity, or} \\ &= (\text{Actual price} \times \text{Actual quantity}) \text{ minus } (\text{Standard price} \\ &\quad \times \text{Actual quantity}) \end{aligned}$$

All unfavourable or adverse variances are taken as positive amounts, whereas favourable variances are prefixed with a negative sign. This is a matter of

convention but the positive or negative signs may altogether be avoided and indication whether the variance is adverse or favourable, given within brackets. Thus, an adverse variance would be written as, Rs. 200 (Adverse or Unfavourable) or Rs. 200 (A) since, by convention, actuals are placed first in the formulae for variances and a favourable variance would be denoted as (-) Rs. 200, Rs. 200 (Favourable), or Rs. 200 (F).

Materials price variance arises due to the following *causes* :

- (i) Change in basic purchase price of material.
- (ii) Change in quantity of purchase or uneconomical size of purchase order.
- (iii) Rush order to meet shortage of supply, or purchase in less or more favourable market.
- (iv) Failure to take advantage of off-season price, or failure to purchase when price is cheaper.
- (v) Failure to obtain (or availability of) cash and trade discounts or change in the discount rates.
- (vi) Weak purchase organisation.
- (vii) Payment of excess or less freight.
- (viii) Transit losses and discrepancies, if purchase price is inflated to include the loss.
- (ix) Change in quality or specification of material purchased
- (x) Use of substitute material having a higher or lower unit price.
- (xi) Change in materials purchase, upkeep, and store-keeping cost. (This is applicable only when such charges are allocated to direct material costs on a predetermined or standard cost basis.)
- (xii) Change in the pattern or amount of taxes and duties

It will be seen that materials price variance is mainly attributable to the purchase department which is responsible for exercising economy by cutting down prices, purchasing in lots when the market is favourable or purchasing from suppliers who offer the most advantageous terms. Circumstances may, however, arise which make price variance largely uncontrollable. Future prices may depend on such factors as market conditions, supply and demand and seasonal variances over which no internal control is possible. In a market where prices are fluctuating or where purchases are intentionally made in uneconomic quantities due to, say lack of working capital, the purchase department may not have control over the price and may not, therefore, be answerable for adverse price variances. But even when no control is possible, price variance analysis provides useful information for taking remedial measures to maintain profit in view of rising material prices, e.g. by increase in product price, use of cheaper substitute materials, or adoption of cost reduction methods. In an inflationary situation where prices of materials are ever rising, the necessity for the fixation of price standards and calculation of price variance are often doubted. In such circumstances although the variance due to inflation may not largely be controllable, price variance analysis will bring out the effect of the efficiency or inefficiency due to other causes (mentioned in sub-para (ii) to (xii) above) which are controllable. Some times the impact of these factors may be much more important than the mere rise in basic purchase price.

(b) *Direct materials usage variance* : This is that portion of materials cost variance which is due to the difference between the actual quantity used and the amount which should have been used, i.e. the standard quantity specified for the actual production, valued at standard price. The formula for the calculation of this variance is :

$$\begin{aligned} \text{Direct materials usage variance} &= (\text{Actual quantity} \times \text{Standard price}) \text{ minus } (\text{Standard} \\ &\quad \text{quantity} \times \text{Standard price}), \text{ or} \\ &= \text{Standard price} \times (\text{Actual quantity} \text{ minus } \text{Standard} \\ &\quad \text{quantity}) \end{aligned}$$

Materials usage variance may be easily determined by adopting a system which allows only standard quantity of material to be drawn on a standard materials requisition, any excess material being specially authorised and issued on a separate requisition (preferably on paper of a different colour) known as *Excess material requisition*.

The causes for materials usage variances are :

- (i) Variation in usage of materials due to inefficient or careless use or economic use of materials.
- (ii) Change in specification or design of product.
- (iii) Inefficient and inadequate inspection of raw materials.
- (iv) Purchase of inferior materials or change in quality of materials.
- (v) Rigid technical specifications and strict inspection leading to more rejections which require more materials for rectification.
- (vi) Inefficiency in production resulting in wastages.
- (vii) Use of substitute materials.
- (viii) Theft or pilferage of materials.
- (ix) Inefficient labour force leading to excessive utilisation of materials.
- (x) Defective machines, tools, and equipments, and bad or improper maintenance leading to breakdowns and more usage of materials.
- (xi) Yield from materials in excess of or less than that provided as the standard yield.
- (xii) Faulty materials processing. Timber, for example, if not properly seasoned may be wasted while being used in subsequent processes.
- (xiii) Accounting errors, e.g. when materials returned from shop or transferred from one job to another are not properly accounted for.
- (xiv) Inaccurate standards.
- (xv) Change in composition of a mixture of materials for a specified output.

A favourable variance may not always be advantageous for the concern. For example, a saving in materials usage may perhaps be effected by reduction in wastage by slowing down the work but the resulting increase in the labour and overhead costs may far exceed the favourable materials usage variance.

Direct materials mix variance : One of the reasons for materials usage variance is the change in the composition of the materials mix. Such a situation arises mainly in the textile, chemical, rubber and similar other industries where definite proportions of different raw materials are mixed to get a product. Sometimes, this variance is separately analysed as materials mix variance. The mix variance

is the difference between the actual quantity of material used and the total quantity in standard proportion, both priced at standard price.

$$\text{Mix variance} = (\text{Quantity in actual mix} - \text{Quantity in standard mix proportions}) \times \text{Standard price}$$

Deviation from the standard composition of a mix may be due to the non-availability of the requisite quantity of one or more of the specified materials for the mix or the use of substitute material. This may be on account of general shortage or due to non-purchase of the material at the proper time, thus indicating the fault of the purchase department. Increase in the proportion of expensive material in a material mix will result in an unfavourable materials mixture variance. On the other hand, favourable mix variance will occur if after value analysis, a cheaper substitute material is used.

Direct materials yield variance : Allied to materials mix variance is another sub-variance termed materials yield variance. This is particularly applicable in the case of process industries where a certain specified yield is expected from a given input of materials but the actual yield is different. Yield variance is the difference between the standard yield of the actual material input and the actual yield, both valued at the standard material cost of the product. Standard yields of the output at each stage, operation, or process may be established. If this is not practicable, the standard may be set for the output at the final stage only when all the processes are complete. A lower actual yield is an unfavourable yield variance which indicates that the consumption of material was more than the standard. A higher actual yield indicates efficiency but a consistent high yield is a pointer for the revision of the standard.

Yield is generally expressed in percentages as shown below :

$$\begin{aligned} \text{Input in a process} &= 120 \text{ Kgs.} \\ \text{Output of the process} &= 100 \text{ Kgs.} \\ \text{Yield from the process} &= \frac{100}{120} \times 100 = 83.3\% \end{aligned}$$

The formula for calculating the yield variance is as follows :

$$\text{Material yield variance} = (\text{Actual yield of input} - \text{Standard yield of actual input}) \times \text{Standard yield price}$$

[Standard yield price is obtained by dividing the total cost of the standard mixture by the total quantity (number of physical units).]

The methods of computing and recording materials cost variances are illustrated below with the help of the following assumed data :

Standard price of materials	Rs. 2.10 per kg.		
Materials purchased	1,000 kgs. @ Rs. 2.00 per kg. => Rs. 2,000		
Materials output	750 kgs.		
Standard quantity of materials allowed for the output	700 kgs.		
The variances will be calculated as follows :-			
	<i>Kgs.</i>	<i>Per Kg.</i>	<i>Amount</i>
Actual quantity used	750	Rs. 2.10 (Standard)	Rs. 1,575
Standard quantity allowed for work done	700	Rs. 2.10 (Standard)	Rs. 1,470
			<hr/>
Materials quantity (or usage) variance	50	Rs. 2.10	Rs. 105(Adv).

	Kgs.	Per Kg.	Amount
Actual quantity used at actual price	750	Rs. 2.00 (Actual)	Rs. 1,500
Actual quantity used at standard price	750	Rs. 2.10 (Standard)	Rs. 1,575
Materials price variance	750	Rs. 0.10	Rs. 75 (Fav.)
Materials cost variance		Rs. 105—Rs. 75	Rs. 30 (Adverse)

The price variance on the total purchase made, which we may term as *purchase price variance*, is worked out as follows :

	Kgs	Per 1 g	Amount
Quantity purchased, at actual price	1,000	Rs. 2.00	Rs. 2,000
Quantity purchased, at standard price	1,000	Rs. 2.10	Rs. 2,100
Purchase price variance	1,000	Rs. 0.10	Rs. 100 (F)

These are three methods for recording the materials purchase variance :

Method 1. Materials when purchased are debited to the Stores Control Account at standard price so that the entire purchase price variance is recorded at the time of purchase. The method is based on the argument that price variance is a function of purchase and not of use of the materials. The standard price is noted at the top in each stores ledger folio and the quantities of receipt and issues are costed at the standard price. The method is simple and it reduces clerical work to a considerable extent.

Journal entries at the time of receipt :

Dr. Stores Control	Rs. 2,100	
(actual quantity \times standard price)		
Cr. Sundry Creditors		Rs. 2,000
(actual quantity \times actual price)		
Cr. Purchase Price Variance		Rs. 100 (Favourable)

Journal entries at the time of materials issues :

Dr. Work-in-Progress	Rs. 1,470	
(standard quantity \times standard price)		
Dr. Materials Quantity Variance	Rs. 105 (Adverse)	
Cr. Stores Control		Rs. 1,575
(actual quantity \times standard price)		

Method 2. The purchase is recorded in the Stores Control Account at cost and the price variance is calculated at the time of issue only along with quantity or usage variance. The price variance is thus worked out only for the quantity issued and not for the entire purchase. The journal entries are :

On receipt :

Dr. Stores Control	Rs. 2,000	
Cr. Sundry Creditors		Rs. 2,000
(actual quantity \times actual price)		

When issued :

Dr. Work-in-Progress	Rs. 1,470	
(standard quantity \times standard price)		
Dr. Materials Quantity Variance	Rs. 105 (Adverse)	
Cr. Stores Control		Rs. 1,500
(actual quantity \times actual price)		
Cr. Materials Price Variance		Rs. 75* (Favourable)
[Actual quantity issued \times actual price]	$= 750 \times \text{Rs. } 2.00 =$	Rs. 1,500
Actual quantity \times standard price	$= 750 \times \text{Rs. } 2.10 =$	Rs. 1,575

*Materials price variance

$= \text{Rs. } 75]$

As historical records have to be maintained under this method, much of the advantage of the standard costing system is lost.

Method 3. If the variances are charged to the Profit and Loss Account at the time of purchase, in accordance with method 1 above, the net profit arrived at may be unrealistic as it would fluctuate depending on the time lag between the purchase and consumption of the materials. To avoid this, the purchase price variance is calculated at the time of purchase as in method 1, but the variance is charged to production only when the materials are issued and that too, only to the extent it relates to the quantity issued; the balance remains merged in the closing stock of materials.

The journal entries are .

On receipt :

Dr. Stores Control	Rs. 2,100	
Cr. Sundry Creditors		Rs. 2,000
Cr. Purchase Price Variance		Rs. 100 (Favourable)

On issue :

Dr. Work in Progress	Rs. 1,470	
Dr. Materials Quantity Variance	Rs. 105 (Adverse)	
Cr. Stores Control		Rs. 1,575
Dr. Purchase Price Variance	Rs. 75	
Cr. Materials Price Variance		Rs. 75

The balance of purchase price variance (i.e. Rs. 100 – Rs. 75 = Rs. 25) remains as a part of the closing stock, to be adjusted in the Balance Sheet as follows : –

Stock of materials (standard)	
(actual quantity × standard price)	Rs. 525
Less Purchase price variance	Rs. 25
Stock of materials (actual)	—
(actual quantity × actual price)	Rs. 500

Two more examples are given to illustrate the analysis of material cost variances :

EXAMPLE 12.1.

The standard material cost for 100 Kgs. of chemical D is made up of

Chemical A	—	30 Kgs. @ Rs. 4.00 per Kg.
„ B	—	40 Kgs. @ Rs. 5.00 per Kg.
„ C	—	80 Kgs. @ Rs. 6.00 per Kg.

In a batch, 500 Kgs. of Chemical D were produced from a mix of

Chemical A	—	140 Kgs. at a cost of Rs. 588
„ B	—	220 Kgs. at a cost of Rs. 1,056
„ C	—	440 Kgs. at a cost of Rs. 2,860

How do the yield, mix, and the price factors contribute to the variance in the actual cost per 100 Kgs. of chemical D over the standard cost? (I.C.W.A., Final)

ANSWER :

Standard mix (100 Kgs.)			Actual mix (500 Kgs.)		
Kgs.	Rate	Amount	Kgs.	Rate	Amount
A 30	Rs. 4.00	Rs. 120	A 140	Rs. 4.20	Rs. 588
B 40	Rs. 5.00	Rs. 200	B 220	Rs. 4.80	Rs. 1,056
C 80	Rs. 6.00	Rs. 480	C 440	Rs. 6.50	Rs. 2,860
					800
150			Less 300		
Less 50 (33⅓%)					
100		Rs. 800	500		Rs. 4,504

Standard weighted average cost = Rs. 800/100 = Rs. 8 per kg.

Actual material cost of 100 Kgs = Rs. 4,504.500 = Rs. 900.80

Material cost variance per 100 kgs. of output = (Actual material cost - standard material cost)
= Rs. 900.80 - Rs. 800.00 = Rs. 100.80 (Adverse)

(a) Materials price variance = Actual quantity \times (Actual price minus Standard price)

$$= \frac{140}{5} \times (Rs. 4.20 - Rs. 4.00) + \frac{220}{5} \times (Rs. 4.80 - Rs. 5.00) \\ = \frac{440}{5} \times (Rs. 0.50 - Rs. 0.60) = Rs. 40.80 \text{ (Adverse)}$$

(b) Material mixture variance = Standard price \times (Actual quantities used minus Quantities in standard proportion)

$$= Rs. 4(25 - 32) + Rs. 5(44 - 42\frac{1}{2}) = Rs. 66.7 \text{ (Adverse)}$$

[Input in actual proportion = 140.5 : 220.5 = 10.5 : 28 = 44 : 98]

Standard mix input = 150 Kgs.

Actual mix input = 160 Kgs.

$$\text{Actual mix in standard proportion} = \frac{160}{150} (30 + 10 + 90) \\ = 12 + 42\frac{1}{2} + 56\frac{1}{2}$$

(c) Material yield variance = Standard yield price \times (Standard yield i.e. standard output expected for actual input minus Actual yield)
= Rs. 8(106\frac{1}{2} - 100) = Rs. 53.33 (Adverse)

$$[\text{Standard output from actual input} = \frac{800}{5} \times 33\frac{1}{2}, \text{ or } \frac{800}{5} \times 106\frac{1}{2}]$$

Standard yield price = Rs. 800/100 = Rs. 8

Summary analysis

Materials price variance		Rs. 40.80 (Adverse)
Materials mixture variance	Rs. 66.7 (Adverse)	
Materials yield variance	Rs. 53.33 (Adverse)	
Materials quantity variance		Rs. 60.00 (Adverse)
Materials cost variance		Rs. 100.80 (Adverse)

EXAMPLE 12.2

In a manufacturing process, the following standards apply

Standard price	Raw material A	Rs. 1 per Kg
	Raw material B	Rs. 5 per Kg
Standard mix	75% A, 25% B (by weight)	

Standard yield (weight of product as percentage of weight of raw materials) 90%

In a period, the actual costs, usages, and output were as follows

Used : 4,400 Kgs A, costing Rs. 4,650

1,600 Kgs B, costing Rs. 7,850

Output : 5,670 Kgs. of product

The budgeted output for the period was 7,200 Kgs

Prepare an operating statement, showing how the material cost variance is built up, and give activity and yield percentages.
(I.C.M.A., Pt. II—Adapted)

ANSWER :

Standard yield from 6,000 (i.e. 4,400 + 1,600) Kgs. of input is 6,000 Kgs. \times 90%, i.e. 5,400 Kgs. of product

Material A	(75%) 4,500 Kgs. \times Rs. 1	= Rs. 4,500
Material B	(25%) 1,500 Kgs. \times Rs. 5	= Rs. 7,500

	6,000 Kgs.	Rs. 12,000
Less	600 Kgs. (loss)	
Output	5,400 Kgs.	Rs. 12,000
Standard cost	$\frac{5,670 \times \text{Rs. } 12,000}{5,400}$	= Rs. 12,600

$$\text{Activity \%} = \frac{\text{Standard yield for actual output}}{\text{Budgeted yield}} = \frac{5,400}{7,200} = 75\%$$

$$\text{Yield \%} = \frac{\text{Actual yield for actual input}}{\text{Standard yield for actual input}} = \frac{5,670}{5,400} = 105\%$$

Actual cost :

Material A	4,400 Kgs.	Rs. 4,650
Material B	1,600 Kg.	Rs. 7,850
	6,000 Kgs.	Rs. 12,500
Less	330 Kgs. (loss)	
	5,670 Kgs.	Rs. 12,500

Variance analysis

Material cost variance = Actual cost - Standard cost = Rs. 12,500 - Rs. 12,600
= Rs. 100 (Fav.)

Price variance = Actual quantity \times (Actual price - Standard price)

Material A : Rs. 4,650 - Rs. 4,400 = Rs. 250 (A)

Material B : Rs. 7,850 - Rs. 8,000 = Rs. 150 (F)
Rs. 100 (A)

Mix variance = Standard price \times (Actual proportion - Standard proportion)

Material A : Rs. 4,500 - Rs. 4,400 = Rs. 100 (F)

Material B : Rs. 7,500 - Rs. 8,000 = Rs. 500 (A)
Rs. 400 (A)

Yield variance = Standard yield price \times (Actual loss - Standard loss)

$$= \frac{\text{Rs. } 12,000}{5,400} \times (330 - 600) = \text{Rs. } 600 \text{ (F)}$$

Total material cost variance = Rs. 100 (A), Rs. 400 (A), and Rs. 600 (F) = Rs. 100 (F)

Operating Statement

Actual cost of material input	Rs. 12,500
Less Price variance (A)	Rs. 100
Standard price of materials	Rs. 12,400
Less Mix variance (A)	Rs. 400
Standard cost of input	Rs. 12,000
Add Yield variance (F)	Rs. 600
Standard cost of output	Rs. 12,600

Direct Labour Cost Variance. Direct labour cost variance (also termed direct wage variance) is the difference between the actual direct wages incurred

and the standard direct wages specified for the activity achieved. The formula for labour cost variance is :

$$\text{Direct Labour cost variance} = (\text{Actual hours} \times \text{Actual rate}) \text{ minus} \\ (\text{Standard hours} \times \text{Standard rate})$$

As in the case of direct material cost variance, direct labour cost variance is analysed into two separate variances, viz. direct labour rate variance and direct labour efficiency variance.

(a) *Direct labour rate variance (Wages rate variance)* : This is that portion of the direct labour variance which is due to the difference between the actual and standard wage rate per hour applied to the total hours worked. Labour rate variance is comparable with materials price variance and is calculated in a similar manner, as illustrated below :

Wages rate variance - (Actual rate minus Standard rate) \times Actual hours

If,

Actual labour hours	100
Standard direct labour per hour	Rs. 5
Actual direct labour per hour	Rs. 5.5

Then,

Actual direct labour cost	100 \times Rs. 5.5	Rs. 550
Standard direct labour cost (for actual hours)	100 \times Rs. 5	Rs. 500
Rate variance	Rs. 550 - Rs. 500	Rs. 50 (A)

Direct labour rate variances occur due to the following :—

- (i) Change in basic wage structure or change in piece-work rate. These will give rise to a variance till such time the standards are not revised.
- (ii) Employment of workers of grades and rates of pay different from those specified, due to shortage of labour of the proper category, or through mistake, or due to retention of surplus labour.
- (iii) Payment of guaranteed wages to workers who are unable to earn their normal wages if such guaranteed wages form part of direct labour cost.
- (iv) Use of a different method of payment, e.g. payment at day-rates while standards are based on piece-work method of remuneration.
- (v) Higher or lower rates paid to casual and temporary workers employed to meet seasonal demands, or urgent or special work.
- (vi) New workers not being allowed full normal wage rates.
- (vii) Overtime and night shift work in excess of or less than the standard, or where no provision has been made in the standard. This will be applicable only if overtime and shift differential payments form part of the direct labour cost.
- (viii) The composition of a gang as regards the skill and rates of wages being different from that laid down in the standard.

Labour rates are usually determined by factors beyond the control of the personnel department, such as conditions in the labour market, wage awards by wage tribunals and boards, etc. Labour rate variances are, therefore, mostly uncontrollable except for the portion which arises due to deployment of wrong grade of labour, use of different mode of payment, overtime work or such other controllable factors for which the departmental executive may be held responsible.

(b) *Direct labour efficiency variance (also termed labour time variance)* : This is the portion of the direct labour variance which is due to the difference between that standard hours for the actual production achieved and the hours actually worked, valued at the standard labour rate. This is similar to the material quantity or usage variance.

Direct labour efficiency variance is the result of taking more or less time than the standard for the performance of an operation or process and it may arise whether day work or an incentive method of payment is in use.

The formula for calculating direct labour efficiency variance is :

Direct labour efficiency variance (Actual hours worked *minus* Standard hours for actual production) \times Standard rate

If,

Standard wage rate	Rs. 4 per hour
Incentive element	Re. 1 per standard hour
Actual hours	100
Standard hours	90
Actual cost	(Rs. 4 \times 100 + Re. 1 \times 90) Rs. 490
Standard cost	(Rs. 4 \times 90 + Re. 1 \times 90) Rs. 450

Efficiency Variance

Rs. 40 (A)

The *causes* giving rise to direct labour efficiency variance are as follows :—

- (i) Lack of proper supervision or stricter supervision than specified.
- (ii) Poor working conditions.
- (iii) Delays due to waiting for materials, tools, instructions, etc. if not treated as idle time.
- (iv) Defective machines, tools and other equipments.
- (v) Machine break-down, if not booked to idle time.
- (vi) Work on new machines requiring less time than provided for, so long as the standard is not revised.
- (vii) Basic inefficiency of workers due to low morale, insufficient training, faulty instructions, incorrect scheduling of jobs, etc.
- (viii) Use of non-standard material requiring more or less operation time.
- (ix) Carrying out operations not provided for and booking them as direct wages.
- (x) Incorrect standards.
- (xi) Wrong selection of workers, e.g. not employing the right type of man for doing a job.
- (xii) Increase in labour turnover.
- (xiii) Incorrect recording of performances, i.e. time or output.

Calculation of wages variance is illustrated below :

EXAMPLE 12.3.

From the following figures, calculate (a) Wages variance, (b) Wages rate variance, and (c) Labour efficiency variance.

Actual hours worked	.	5,600
Actual wages paid	..	Rs. 15,680
Standard rate per hour	.. ..	Rs. 4
Standard hours produced	.. ..	4,000

ANSWER :

Wages variance	$4,000 \times \text{Rs. } 4 - \text{Rs. } 15,680$	<u>Rs. 320 (Fav)</u>
Wages rate variance	$5,600 \times \left(\text{Rs. } 4 - \frac{\text{Rs. } 15,680}{5,600} \right)$	Rs. 6,720 (Fav)
Labour efficiency variance	$\text{Rs. } 4 \times (4,000 - 5,600)$	$= \text{Rs. } 6,400 \text{ (Adv)}$
		<u>Rs. 320 (Fav)</u>

Mention may be made of a few *subsidiary variances* related to direct material and labour costs.

Scrap variance : This variance is a part of the material usage (or materials yield) variance and is represented by the difference between the scrap allowance in the budget and scrap expenses incurred. The anticipated quantity of scrap for each process or operation is technically assessed and set as the standard. The actual quantity of scrap is ascertained and compared with the standard. The scrap variance is calculated according to the following formula :—

$$\text{Scrap variance} = (\text{actual quantity of scrap} \times \text{standard scrap price}) \\ \text{minus} (\text{standard quantity of scrap} \times \text{standard scrap price})$$

Quality cost variance : This is the difference (arising from failure to conform to quality specification) between the amount included in standard costs and the actual cost or loss incurred in scrapping, rectifying, or selling at sub-standard prices.

$$\text{Quality cost variance} = (\text{Number of units rejected or returned} \\ \times \text{cost per unit} + \text{Rectification cost} \\ - \text{Disposal value}) \text{ minus } (\text{Number of units} \\ \text{produced} \times \text{standard allowance per unit})$$

Substitution variance : This is a variance in labour cost which arises due to substitution of labour, e.g. when one grade of worker is substituted by another. This is denoted by the difference between the actual hours at standard rate of standard worker and the actual hours at standard rate of actual worker. If the standard rate of a Grade A worker is Re. 5 per hour and he is employed for 500 hours to do a work scheduled to be done by a Grade B worker of standard rate of Rs. 4 per hour :

$$\text{Substitution variance} = (500 \times \text{Rs. } 5) - (500 \times \text{Rs. } 4) = \text{Rs. } 500 \text{ (A)}$$

Gang composition variance or Labour mix variance : This is a sub-variance of wages rate variance. The method of calculation of this variance, which arises due to change in the composition of a standard gang, or combination of labour force is illustrated below :

Standard gang

2 men @ Rs. 5 per hour
5 men @ Rs. 4 per hour
1 man @ Rs. 6 per hour
Standard cost per hour = Rs. 36 (i.e. $2 \times \text{Rs. } 5 + 5 \times \text{Rs. } 4 + 1 \times \text{Rs. } 6$)

Actual gang (at standard rate of wages)

4 men @ Rs. 5 per hour
2 men @ Rs. 4 per hour
2 men @ Rs. 6 per hour
Actual cost per hour = Rs. 40 (i.e. $4 \times \text{Rs. } 5 + 2 \times \text{Rs. } 4 + 2 \times \text{Rs. } 6$)

Actual hours taken in a week = 48

$$\text{Gang composition variance} = \text{Actual hours at standard rate of actual gang} \text{ minus} \\ \text{Actual hours at standard rate of standard gang} \\ = (48 \times \text{Rs. } 40) - (48 \times \text{Rs. } 36) = \text{Rs. } 192 \text{ (A)}$$

Idle time variance : This variance which forms a portion of wages efficiency variance, is represented by the standard cost of the actual hours for which the workers remain idle due to abnormal circumstances. The formula is :

$$\begin{aligned} \text{Idle time variance} &= (\text{Actual hours paid for} \times \text{Standard rate}) \text{ minus } (\text{Actual hours worked} \\ &\quad \times \text{Standard rate}), \text{ or} \\ &= \text{Idle hours} \times \text{Standard rate} \end{aligned}$$

If the actual hours in Example 12.3 include 600 hours of abnormal idle time booked and paid for

$$\text{Idle time variance} = 600 \times \text{Rs. 4} = \text{Rs. 2,400 (Adv.) and}$$

$$\text{Labour efficiency variance} = \text{Rs. 4} \times (4,000 - 5,000) = \text{Rs. 4,000 (Adv.)}$$

There is no change in wage rate variance.

Overhead Cost Variances. In a standard cost system, overheads are applied at standard predetermined rates to the standard allowed input. The input can be one of the several bases used for absorbing overheads such as labour hours, machine hours, units of output etc. but in standard costing, direct labour hour is the basis generally in use. Thus the standard overhead cost pertaining to a job or process is equal to standard labour hours allowed \times standard overhead rate (standard hours allowed \div standard labour hours required to produce one unit \times actual number of units produced).

Overhead cost variance or overall (or net) overhead variance is the difference between the actual overhead incurred and the overhead charged or applied into the job or process at the standard overhead rate. Overhead cost variance and its component variances may be computed and analysed separately for fixed and variable overheads and for each cost centre.

In order to explain the overhead variance, we shall assume the following data

	Department A			
	Flexible budget (Month)			
Capacity (% of normal)	90%	100%	100%	
Standard production	900	1,000	1,100	
Direct labour hours	9,000	10,000	11,000	
Variable overhead	Rs	Rs	Rs	
Indirect materials				
Indirect labour				
Stores				
Repairs				
Power and light				<i>Variable overhead</i>
Total	Rs 10,800	Rs 12,000	Rs 13,200	<i>standard rate</i>
				Rs 1.20 per direct labour hour
Fixed overhead	Rs	Rs	Rs	
Supervision				
Maintenance				
Rate and taxes				
Maintenance				<i>Fixed overhead</i>
Total	Rs 14,000	Rs 14,000	Rs 14,000	<i>standard rate</i>
				Rs 14,000 per month or
				Rs 1.40 per direct labour hour at normal capacity
				<i>Total overhead</i>
				<i>standard rate at normal capacity</i>
Total overhead	Rs. 24,800	Rs. 26,000	Rs 27,200	Rs 14,000 + Rs. 1.20 per direct labour hour or
				Rs. 2.60 per standard direct labour hour

Actual units produced : 950

Actual direct labour hours used : 9,900

Actual overhead incurred : Rs. 25,000 (11,000V + 14,000F)

From the above information, we shall make the calculations that will be required for the variance analysis.

1. Standard hours allowed for the output = 950 units \times 10 units per hour = 9,500
2. Budget allowance for actual hours worked (i.e. for actual quantity of input used)

(a) Fixed overhead	Rs. 14,000
(b) Variable overhead	
(9,900 hours \times Rs. 1.20)	Rs. 11,880
(c) Total	Rs. 25,880
3. Actual hours \times standard overhead rate

(a) Actual hours \times variable overhead standard rate	9,900 \times Rs. 1.20	Rs. 11,880
(b) Actual hours \times fixed overhead standard rate	9,900 \times Rs. 1.40	Rs. 13,860
(c) Actual hours \times total overhead standard rate	9,900 \times Rs. 2.60	Rs. 25,740
4. Budget allowance based on standard hours allowed, i.e. the flexible budget for standard hours for actual output (units produced)

(a) Fixed	Rs. 14,000
(b) Variable	
(9,500 \times Rs. 1.20)	Rs. 11,400
(c) Total	Rs. 25,400
5. Overhead applied to actual production :

(a) Variable	9,500 hours \times Rs. 1.20	Rs. 11,400
(b) Fixed	9,500 hours \times Rs. 1.40	Rs. 13,300
(c) Total	9,500 hours \times Rs. 2.60	Rs. 24,700
6. Actual overhead Rs. 25,000

The overhead total cost variance is computed as follows :

Actual overhead (6)	Rs. 25,000
Overhead applied (5c)	Rs. 24,700
Overhead total cost variance	Rs. 300 (Adverse)

The overhead total cost variance is further analysed to determine the detailed causes for the variance and to assist the management in taking corrective measures. The analysis may be made under two, three or four variances.

Two-variance method. In this method, two variances are calculated. These are (i) controllable variance and (ii) volume variance. In effect, the two variances represent variable overhead variance and fixed overhead variance respectively.

(i) Controllable variance is the difference between the overhead actually incurred and the budget allowance based on standard hours allowed.

Overhead actually incurred (6)	Rs. 25,000
Budget allowance based on standard hours allowed (4c)	Rs. 25,400
Controllable variance	Rs. 400 (F)

The controllable variance consists of variable overhead only (controllable by the departmental manager) and may also be calculated by including only the variable overhead in the calculations :

Variable overhead incurred	Rs. 11,000
Budget allowance for variable overhead based on standard hours allowed (4b)	Rs. 11,400
Controllable variance	Rs. 400 (F)

(ii) Volume variance is the difference between the budget allowance based on standard hours allowed and the overhead applied to production.

Budget allowance based on standard hours

allowed (4c)	=Rs. 25,400
Overhead applied to production (5c)	=Rs. 24,700
Volume variance	=Rs. 700 (A)

The volume variance consists of fixed overhead only and may also be calculated as follows :—

Normal capacity hours	10,000
Standard hours allowed for actual output (1)	9,500
Capacity hours not utilized and or not efficiently utilized	500
	Rs. 1.40
Volume variance	Rs. 700 (A)

An analysis of the volume variance is made to find out its causes. These are practically the same which result in idle time or working overtime ; some are controllable and the rest uncontrollable. The causes are :

Waiting for tools, work, instructions, etc.

Power failure

Machine breakdown

Shortage of material

Idle or excess capacity

Variations in customers' demands and orders booked

Labour troubles, e.g. strikes, lock-outs, etc.

Calendar fluctuations

Check for two variances :

Controllable (variable overhead) variance	Rs. 400 (F)
Volume (fixed overhead) variance	Rs. 700 (A)
Overall overhead variance	Rs. 300 (A)

Three-variance method. In this method, which is commonly adopted, three variances, viz. (i) expenditure, spending or budget variance, (ii) volume variance (or idle capacity or capacity usage variance) and (iii) efficiency variance are calculated.

(i) Expenditure variance is that portion of the overhead cost variance which is due to the difference between the overhead actually incurred and the flexible budget allowance for the actual quantity of input used, i.e. the actual hours worked. Any change in the level of actual spending in respect of one or the other items of the expenses which constitute the variable overhead cost results in expenditure variance. This variance, therefore, measures the efficiency or otherwise, in spending and the departmental manager who is expected to incur expenditure within the budget limits is responsible for this variance.

Overhead actually incurred (6)	= Rs. 25,000
Budget allowance for actual hours worked (2c)	= Rs. 25,880
Expenditure variance	= <u>Rs. 880 (A)</u>

Expenditure variance consists of variable overhead only unless the level of fixed overhead also undergoes a change. This will be apparent if we eliminate fixed overhead from the formula (being common for the actual overhead and budget allowance for actual hours)

Variable overhead incurred	Rs. 11,000
Variable budget allowance for actual hours worked (2b)	Rs. 11,880
Expenditure variance	Rs. <u>880 (A)</u>

(ii) Volume variance arises due to the difference between the normal level of output and the actual level achieved and is that portion of the overhead variance which is the difference between the flexible budget allowance based on actual hours taken and the standard overhead cost absorbed by the actual hours

Budget allowance based on actual hours (2c)	Rs. 25,880
Actual hours total overhead standard rate (3c)	Rs. 25,740
Volume variance	= <u>Rs. 140 (A)</u>

This variance represents the amount of fixed overhead that is under- or over-absorbed because of the difference between the actual hours and the hours on which the overhead rate was calculated

(Normal capacity hours - Actual hours) × Fixed overhead standard rate	
(10,000 - 9,900) × Rs. 1.40	Rs. 140 (A)

(iii) Efficiency variance is that portion of the overhead variance which is due to the difference between the standard overhead applied on actual hours and the standard overhead cost of the production achieved, i.e. the overhead applied to actual production.

Actual hours × standard overhead rate (3c)	= Rs. 25,740
Overhead applied to production (5c)	= Rs. 24,700
Efficiency variance	= <u>Rs. 1,040 (A)</u>

This variance arises because the actual hours used are more or less than the standard hours allowed and consists of both fixed and variable overheads. Inefficiencies in the use of labour, change in operations, uses of different types of materials, new tools etc. are the main causes of efficiency variance. If the overhead recovery base adopted is direct labour hours or direct wages value, the efficiency variance will reflect the labour efficiency variance. Similarly, if machine hours are used as the base, machine usage efficiency will be brought out and so on for the other overhead application bases used.

Efficiency variance may also be simply worked out as follows :—

$$(\text{Actual hours} - \text{Standard hours for actual output}) \times \text{Standard overhead rate} = (9,900 - 8,860) \times \text{Rs. 2.6} = \text{Rs. 1,040 (A)}$$

Check for three variances :

Expenditure variance	Rs. 880 (F)
Volume variance	Rs. 140 (A)
Efficiency variance	Rs. 1,040 (A)
Overall overhead variance	Rs. 300 (A)

Four-variance method. In this method, four variances, viz. (i) Expenditure variance, (ii) Variable efficiency variance, (iii) Fixed efficiency variance, and (iv) Volume variance are worked out

(i) Expenditure variance is the same as that for three-variance method : here, Rs. 880 (F)

(ii) Variable efficiency variance is that portion of the overhead cost variance which is due to the difference between the variable budget allowance for actual hours worked and the variable budget allowance based on standard hours allowed.

Variable overhead budget allowance for actual hours worked (2b)	Rs. 11,880
Variable budget allowance for standard hours allowed (4b) •	Rs. 11,400
Variable efficiency variance	Rs. 480 (A)
or, Variable efficiency variance = (Actual hours – Standard hours allowed) × Standard variable overhead rate (9,900 – 9,500) Rs. 1.20	= Rs. 480 (A)

(iii) Fixed efficiency variance is that portion of the overhead cost variance which is the difference between the standard fixed overhead rate applied to actual hours and standard fixed overhead rate applied to standard hours allowed.

Actual hours – Standard fixed overhead rate (3b)	Rs. 13,860
Standard allowed hours – Standard fixed overhead per hour (or fixed overhead applied to production) (5b)	Rs. 13,300
Fixed efficiency variance	Rs. 560 (A)
or Fixed efficiency variance = (Actual hours – Standard allowed hours) × Standard fixed overhead rate (9,900 – 9,500) Rs. 1.40	= Rs. 560 (A)

(iv) Volume variance is identical with that in the three-variance method : here, Rs. 140 (A)

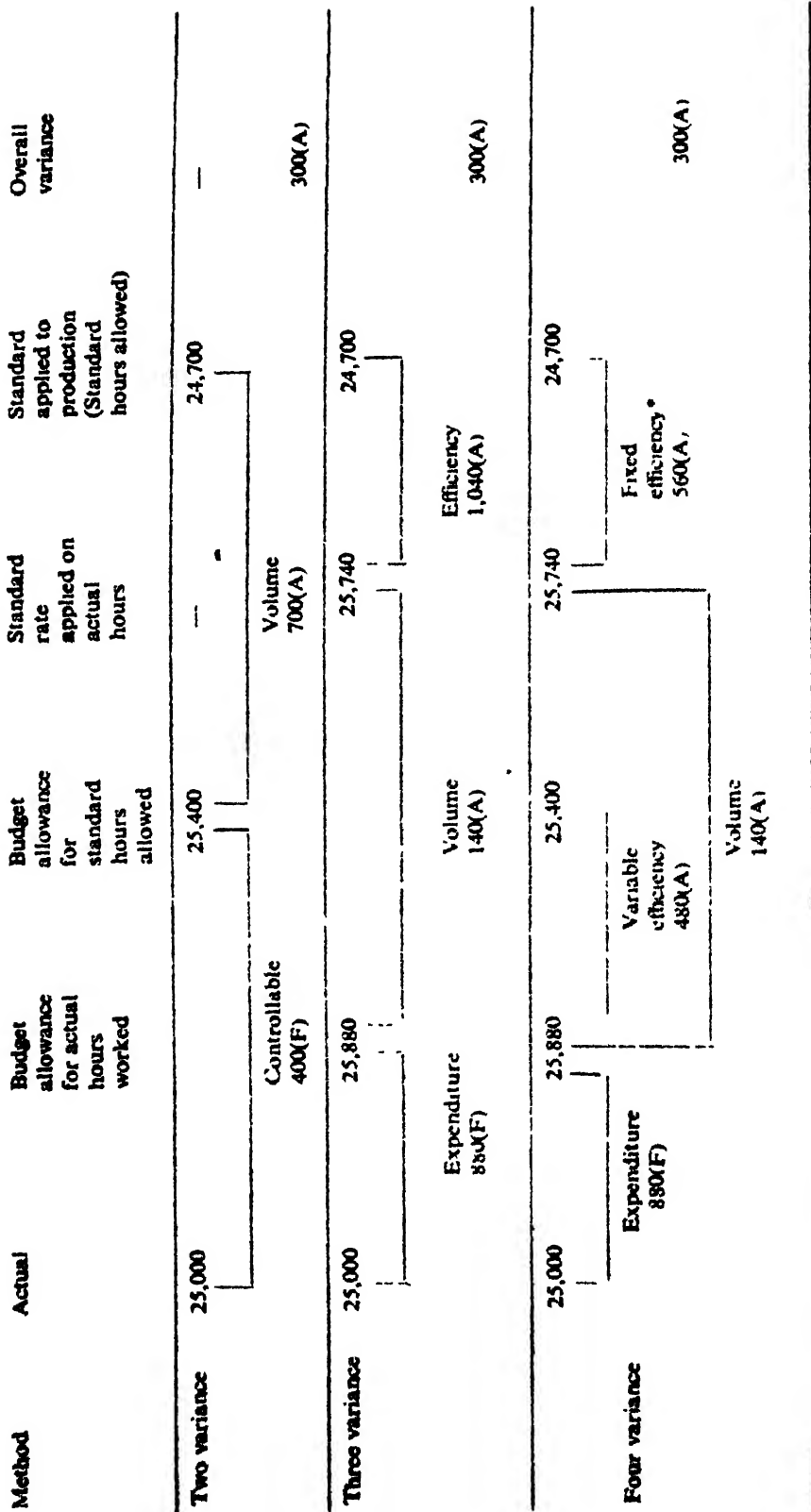
Check for four variances :

Expenditure variance	Rs. 880 (F)
Variable efficiency variance	Rs. 480 (A)
Fixed efficiency variance	Rs. 560 (A)
Volume variance	Rs. 140 (A)
Overall overhead variance	Rs. 300 (A)

A summary of the three methods used is given in the table in Fig. 12.3

A comparison of the results obtained under the three methods indicates the following :

(a) Expenditure variance + variable efficiency variance, of four-variance	= Controllable variance of two-variance
(b) Volume variance + fixed efficiency variance of four-variance	= Volume variance of two-variance



*Applying standard fixed overhead rate only

Fig. 12.3. Two, Three and Four Variances.

- | | | |
|---|-------|-----------------------|
| (c) Variable efficiency variance | fixed | — Efficiency variance |
| efficiency variance, of four-variance | | of three-variance |
| (d) Expenditure variance of four-variance | | Expenditure variance |
| | | of three-variance |
| (e) Volume variance of four-variance | | Volume variance |
| | | three-variance |

It will be seen from item (b) above, that volume variance under the two variance method can be analysed into (i) volume variance under three-variance method (also known as idle capacity variance or capacity usage variance) and (ii) fixed efficiency variance (also known as volume efficiency variance). While the idle capacity variance indicates that out of the normal capacity of 10,000, only 9,900 hours were utilized leaving an unutilized balance capacity of 100 hours the fixed cost relating to which was Rs 140, the fixed efficiency variance shows how effectively or ineffectively the available capacity was employed. The efficiency variance in the present case informs that 9,900 hours were utilized where 9,500 would have been sufficient, resulting in additional fixed cost of Rs 560.

The above methods of analysing overhead variance are illustrative of the practices generally followed. It should however, be noted that there being no terminology that can be uniformly adopted in all countries, accountants give different names to the variances, interpret them in different ways, combine sub-variances according to their needs and carry out detailed analysis to present a number of additional variances.

Sub-Variances. Overhead expenditure variance may be analysed under price and quantity (or usage) variance. In the two-variance analysis (see Page 650) efficiency variance is treated as another sub-variance of expenditure variance.

Overhead price variance is that portion of the overhead expenditure variance which is due to the difference between the standard price of the service specified and the actual price paid.

Overhead utilization variance is that portion of the overhead expenditure variance which is due to the difference between the standard quantity of the service specified and the actual quantity of the service used.

Volume variance is also analysed into a number of sub-variances. The components of volume variance are seasonal variance, calendar variance, idle capacity variance (or capacity usage variance), and fixed efficiency variance (or volume efficiency variance). The last two were discussed earlier.

Seasonal variance : This is that portion of the volume variance which is due to the difference between the budgeted seasonal output and the average output on which standards have been calculated. If a complete year be taken as a cycle, the sum of the seasonal variances over a complete year will be zero. Similar situation arises when the standard level of activity is based upon the normal capacity expected over a number of years constituting the business cycle.

Calendar variance : This is that portion of the volume variance which is due to the difference between the number of working days in the budget period and the number of actual working days in the period to which the budget is applied. Though the amount of fixed overhead is constant for each period, this variance

arises from the fact that the length of one accounting period is different from another and the number of working days taken into account for establishing the standard may be different from the actual number of working days during the budget period under consideration. If a calendar month is taken as an accounting period, the number of days in the various months differ. Even when the whole year is divided into thirteen periods having the same number of days in each, the uneven number of holidays falling in each period results in a calendar variance. It will be seen that calendar variance is actually volume variance arising due to a particular cause, namely fluctuations in the length of the accounting period. For a proper study of volume variance, it is essential to segregate the calendar variance.

Computation of calendar variance is illustrated below :

$$\begin{aligned} & \text{Calendar variance (Standard hours for actual number of days / Standard overhead} \\ & \text{rate) minus (Standard overhead for standard period), or} \\ & \text{(Actual number of working days minus Standard number of working} \\ & \text{days) } \times \frac{\text{Standard or budgeted overhead cost}}{\text{Standard number of days}} \end{aligned}$$

If standard labour hours be 1,000 for a standard month based on 24 working days, and the standard overhead rate be Rs. 3 per hour, the calendar variance arising due to 22 actual working days will be :

$$\frac{1,000 \times 22}{24} \times \text{Rs. 3} = 1,000 \times \text{Rs. 3} \quad \text{--Rs. 250 (A)}$$

$$\text{or, } (22-24) \times \frac{1,000 \times \text{Rs. 3}}{24} \quad \text{Rs. 250 (A)}$$

Calendar variance may be eliminated by apportioning standard allowance and actual fixed cost on working days basis. As in the case of seasonal variance, the sum total of the calendar variances during a complete year will be nil.

Capacity usage variance : This is that portion of the volume variance which is due to working at higher or lower capacity usage than standard.

Volume efficiency variance : This is that portion of the volume variance which reflects the increased or reduced output arising from efficiency above or below the standard expected.

The method of calculating volume variance and its components is illustrated below :

	Hours	Units
Annual budgeted production	50 wks. / 6 days / 8 hrs. = 2,400 (or 200 per month)	1,80,000 (or 15,000 per month)
Production Standard per hour		75
Annual budgeted fixed overhead	Rs. 2,70,000	
(Note that the annual budgeted production is the normal capacity)		

Data for a particular month

	Hours	Units
Actual production		14,500
Actual hours worked	180	
Budgeted hours	4 wks. / 6 days / 8 hrs. = 192	
Hours idle time	1 day = 8 hrs.	
Revised budgeted hours	192 - 8 = 184	
Seasonal budgeted production for the month	240	18,000

(i) Calculation on the basis of units of production :

Standard overhead rate	$\frac{\text{Rs. } 2,70,000}{1,80,000} = \text{Rs. } 1.5 \text{ per unit}$
Volume-variance	$\rightarrow \text{Standard rate} \times (\text{Actual units} - \text{Budgeted units})$ $\rightarrow \text{Rs. } 1.5 (14,500 - 15,000) = \text{Rs. } 750 \text{ (A)}$
Volume efficiency variance	$\rightarrow \text{Standard rate} \times (\text{Actual units} - \text{Standard units})$ $\rightarrow \text{Rs. } 1.5 (14,500 - 13,500) = \text{Rs. } 1,500 \text{ (F)}$
[Standard units]	$\frac{\text{Actual hours worked}}{\text{Standard units per hour}}$ $\rightarrow 180 \times 75 = 13,500$
Capacity usage variance	$\rightarrow \text{Standard rate} \times (\text{Standard units} - \text{Revised budgeted units for revised working hours})$ $\rightarrow \text{Rs. } 1.5 (13,500 - 14,375) = \text{Rs. } 1,312.5 \text{ (A)}$

$$[\text{Revised budgeted units for revised working hours} = 15,000 \times \frac{184 \text{ hours}}{192 \text{ hours}}]$$

Calendar variance	$\rightarrow \text{Standard rate} \times (\text{Revised budgeted units} - \text{Seasonal budgeted units})$ $\rightarrow \text{Rs. } 1.5 (14,375 - 18,000) = \text{Rs. } 5,437.5 \text{ (A)}$
Seasonal variance	$\rightarrow \text{Standard rate} \times (\text{Seasonal budgeted units} - \text{Budgeted units})$ $\rightarrow \text{Rs. } 1.5 (18,000 - 15,000) = \text{Rs. } 4,500 \text{ (F)}$

(ii) Calculation based on hours of production :

Standard Overhead rate	$\frac{\text{Rs. } 2,70,000}{2,400} = \text{Rs. } 112.5 \text{ per hour}$
Volume variance	$\rightarrow \text{Standard rate} \times (\text{Standard hours for actual production} - \text{Budgeted hours})$ $\rightarrow \text{Rs. } 112.5 (193\frac{1}{4} - 200) = \text{Rs. } 750 \text{ (A)}$
(Standard hours for actual production)	$\rightarrow \frac{14,500}{75} = 193\frac{1}{4}$
Volume efficiency variance	$\rightarrow \text{Standard rate} \times (\text{Standard hours} - \text{Actual hours})$ $\rightarrow \text{Rs. } 112.5 (193\frac{1}{4} - 180) = \text{Rs. } 1,500 \text{ (F)}$
Capacity usage variance	$\rightarrow \text{Standard rate} \times (\text{Actual hours} - \text{Revised budgeted hours})$ $\rightarrow \text{Rs. } 112.5 (180 - 191\frac{1}{4}) = \text{Rs. } 1,312.5 \text{ (A)}$
[Revised budgeted hours]	$\rightarrow 200 \times \frac{184 \text{ hours}}{192 \text{ hours}} = 191\frac{1}{4}$
Calendar variance	$\rightarrow \text{Standard rate} \times (\text{Revised budgeted hours} - \text{Seasonal budgeted hours})$ $\rightarrow \text{Rs. } 112.5 (191\frac{1}{4} - 240) = \text{Rs. } 5,437.5 \text{ (A)}$
Seasonal variance	$\rightarrow \text{Standard rate} \times (\text{Seasonal budgeted hours} - \text{Budgeted hours})$ $\rightarrow \text{Rs. } 112.5 (240 - 200) = \text{Rs. } 4,500 \text{ (F)}$

There are certain variances which may arise under materials, labour, or overhead due to change in the basic condition on which standards are established. These are revision variance and methods variance.

Revision variance : This is the amount by which a budget is revised, but which is not incorporated in the standard cost rate, as a matter of policy. The standard costs are sometimes affected by certain uncontrollable factors like wage rate change on account of wage awards, government fiscal policy, sudden changes in material price, etc. There is not much use disturbing the standard costs to account for these uncontrollable factors, and in order to avoid the amount of

labour and cost involved in revision, the basic standards are allowed to stand. In order, therefore, to correctly analyse the other variances, it is essential to isolate the variance arising out of non-revision of standards.

Methods variance : This is that portion of total cost variance which is due to the use of methods other than those specified. It is the difference between the standard cost of the product manufactured or operation performed by the normal methods and the standard cost of the product manufactured or operation performed by the alternative method actually employed. As at the time of establishment, standards usually take into account the best methods applicable, any deviation therefrom will result in an unfavourable variance. Such deviations should, therefore, be few and should arise temporarily for short periods only, pending revisions of the standards.

A few examples to show the methods of calculation of cost variances are given here.

EXAMPLE 12.4.

The weekly budget for performance and overhead costs in a manufacturing department is based upon the following figures :

Number of operators	20
Working week	40 hours
Budgeted lost time	12½ % of total hours worked
Budgeted efficiency	One standard hour per actual hour worked
Budgeted overheads .	
Fixed	Rs. 350
Variable with operator hours	Rs. 525
Variable with output	Rs. 175

Detail on a suitable statement, the overhead variances which have arisen in a week when the actual performance and costs were as follows :—

Net operator working hours	620
Standard hours produced	650
Overhead :	
Fixed	Rs. 350
Variable with operator hours	Rs. 510
Variable with output	Rs. 190

(I.C.M.A., Pt. IV—Adapted)

ANSWER :

Standard overhead rates are worked out as follows :

Budgeted working hours = (20 operators × 40 hours) minus 12½ % for lost time = 700
Standard recovery rates :

Fixed	$\frac{\text{Rs. } 350}{700} = \text{Re. } 0.50 \text{ per standard hour}$
Variable with operator hours	$\frac{\text{Rs. } 525}{700} = \text{Re. } 0.75 \text{ per operator hour}$
Variable with output	$\frac{\text{Rs. } 175}{700} = \text{Re. } 0.25 \text{ per standard hour}$

Overhead Variance Statement

	Fixed overhead variance		Variable (with operator hours) overhead variance		Variable (with output) overhead variance	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Actual expenditure	350		510		190	
Budgeted expenditure	350		465		163	
			$(620 \times \text{Re. } 0.75)$		$(650 \times \text{Re. } 0.25)$	
Expenditure variance		Nil		45(A)		27(A)
Budgeted expenditure	350					
Capacity utilised	310					
	$(620 - \text{Re. } 0.50)$					
Capacity variance		40(A)				
Capacity utilized	310					
Standard hours produced	325		465			
	$(650 - \text{Re. } 0.50)$		487			
Efficiency variance		15(F)	$(650 - \text{Re. } 0.75)$			
				22(F)		
Overhead cost variance		25(A)		23(A)		27(A)

Note : When overhead is taken to vary with quantity of output, no efficiency variance is revealed.

EXAMPLE 12.5.

The standard cost of a product is as under :

Materials	20 lbs. M S Plate	Rs. 5.00
Labour	15 hours @ 50 P per hour	Rs. 7.50
Overhead	15 hours @ Re. 1 per hour	Rs. 15.00
		<hr/>
		Rs. 27.50

Standard labour hours per month, 30,000

For the month of April 1972, which was the first month of production, the number of units completed were 1,800. A further 400 units were half completed with respect to materials, labour and overheads. Other particulars available for April 1972, are :

Materials issued	42,000 lbs
Materials purchased	50,000 lbs. @ 23 P per lb.
Wages paid	29,500 hours @ 52 P per hour
Overheads	Rs. 33,000

Analyse the variances in as much details as possible and compute the manufacturing cost per unit.
(I.C.W.A., Final)

ANSWER :

The total output is 2,000 units, arrived at as follows :

Finished product	1,800 units
In process, 400 half completed	200 units
	<hr/>
Total output	2,000 units

Cost variances per unit are determined as follows :—

(i) *Material cost variances :*

Actual price = Rs. 0.23 ; Standard price = Re. 0.25

Actual quantity = $\frac{42,000}{2,000} = 21$ lbs ; Standard quantity = 20 lbs.

Overall variance = $21 \times \text{Re. } 0.23 - 20 \times \text{Re. } 0.25 = \text{Re. } 0.17$ (Fav)

Price variance = $21 \times \text{Re. } (0.23 - 0.25) = \text{Re. } 0.42$ (Fav)

Quantity variance = $\text{Re. } 0.25 \times (21 - 20) = \text{Re. } 0.25$ (Adv)

(Algebraic signs are ignored)

(ii) *Labour cost variances :*

Actual hours	$= \frac{29,500}{2,000} = 14.75$; Standard hours = 15
Actual rate	= Re. 0.52 ; Standard rate = Re. 0.50
Overall variance	= $14.75 \times \text{Re. } 0.52 - 15 \times \text{Re. } 0.50 = \text{Re. } 0.17$ (Adv)
Wages rate variance	= $14.75 (\text{Re. } 0.52 - \text{Re. } 0.50) = \text{Re. } 0.295$ (Adv)
Labour efficiency variance	= $0.50 (14.75 - 15.00) = \text{Re. } 0.125$ (Fav)

(iii) *Overhead variances :*

Standard hours	= 30,000
Actual hours	29,500
Standard overhead	Re. 1 per hour
Actual overhead	= Rs. 33,000
Overall overhead variance	$(33,000 - 30,000) \times \text{Re. } 1 = \text{Rs. } 3,000$ (Adv)
	$\text{Rs. } 3,000$ i.e. $\frac{3,000}{2,000} = \text{Rs. } 1.50$ per unit (Adv)
Expenditure variance	$(33,000 - 29,500) \times \text{Re. } 1 = \text{Rs. } 3,500$ (Adv), i.e. Rs. 1.75 per unit (Adv)
Efficiency variance	= $(29,500 - 30,000) \times \text{Re. } 1 = \text{Rs. } 500$ (Fav), i.e. Re. 0.25 per unit (Fav)

Manufacturing cost per unit is computed as follows :

Materials		
Standard cost	Rs. 5.00	
Less variance (F)	Re. 0.17	
		Rs. 4.83
Labour		
Standard cost	Rs. 7.50	
Add variance (A)	Re. 0.17	
		Rs. 7.67
Overhead		
Standard cost	Rs. 15.00	
Add variance (A)	Rs. 1.50	
		Rs. 16.50
Total cost		Rs. 29.00

EXAMPLE 12.6.

The following cost details apply to a manufacturing department :

	Standard overhead monthly Rs.	Actual overhead for month Rs.
Variable :		
Consumables	400	380
Repairs and maintenance	150	140
Indirect wages	1,000	960
Power	150	140
Building services	300	300
Total	Rs. 2,000	Rs. 1,920
Fixed :		
Supervision	500	630
Depreciation	800	800
Rates, insurance, etc.	100	110
Total	Rs. 1,500	Rs. 1,540
Grand total	Rs. 3,500	Rs. 3,460

Standard hours per month	1,750	
Overhead per standard hour	Rs. 2	
Actual hours during month		1,600
Evaluation at standard rate of actual production		Rs. 3,300
Standard hours represented by actual output		1,650
What variances, classified as to type of expense and to cause, have occurred during the month, and what are their amounts?		
(J.C.W.A., Final)		

ANSWER .

The variances in respect of variable and fixed overheads are computed separately. It is assumed that because variable overhead items vary proportionate to output, there should be only one type of variance, viz. expenditure variance.

Variable overhead

	Actual Rs.	Standard Rs.	Variance Rs.
Consumables	380	400	(-) 20
Repairs and maintenance	140	150	(-) 10
Indirect wages	960	1,000	(-) 40
Power	140	150	(-) 10
Building services	300	300	—
Total	Rs. 1,920	Rs. 2,000	Rs. 80(F)

Fixed overhead

	(a)	(b)	(c)	(d)	Variance				
	Standard	Actual	Budget for capacity utilised 1,600 hours	Budget for standard hours of actual output, 1,650 hours	Expenditure	Capacity	Efficiency	Volume	Overall
	Rs.	Rs.	Rs.	Rs.	(b-a)	(a-c)	(c-d)	(a-d)	(b-d)
Supervision	600	630	548*	565**	30(A)	52(A)	17(F)	35(A)	65(A)
Depreciation	800	800	711	754	—	69(A)	23(F)	46(A)	46(A)
Rates, Insurance etc.	100	110	91	94	10(A)	9(A)	3(F)	6(A)	16(A)

$$* \frac{600}{1,750} \times 1,600$$

$$** \frac{600}{1,750} \times 1,650$$

Reporting of Variances. The objectives of variance analysis and the necessity for reporting the results of the analysis to the management, were discussed earlier. In order that variance reporting should be effective, it is essential that the following conditions are fulfilled :—

- (i) The variances arising out of each factor should be correctly segregated. If part of a variance due to one factor is wrongly attributed to or merged with that of another, the analysis report submitted to the management would be misleading and wrong conclusions may be drawn from it.
- (ii) Variances, particularly the controllable variances should be reported with promptness as soon as they occur. Mere operation of standard costing and reporting of variances is of no avail. The success of a

standard costing system depends on the extent of responsibility the management assumes in correcting the conditions which cause variances from standard. In order to assist the management in assuming this responsibility, the variances should be reported frequently and on time. This would enable corrective action being taken for future production while work is in progress and before the project or job is completed.

Delay in variance analysis creates difficulties in placing responsibilities, and wastes, losses, and inefficiencies, if not corrected, continue to increase. Usually labour and material costs variances are reported on a day-to-day basis and the overhead variance on a weekly or monthly basis.

- (iii) For effective control, the line of organisation should be properly defined and the authority and responsibility of each individual should be laid down in clear terms. This will avoid 'passing on the buck' and shirking of responsibility and will enable the tracing of the causes of variances to the appropriate levels of management.
- (iv) In certain cases, a particular variance may be the joint responsibility of more than one individual or department. It is obvious that if corrective action has to be effective in such cases, it should be taken jointly.
- (v) Analysis of uncontrollable variances should be made with the same care as for controllable variances. Though a particular variance may not be controllable at the lower level of management, a detailed analysis of the off-standard situation may reveal far reaching effects on the economy of the concern. This should compel the top management to take corrective action, say, by changing the policy which gave rise to the uncontrollable variance.

Forms of Variance Reports. The forms of reports for the different types of variances should be designed keeping in view the needs of the management and the size of the concern, and no standard forms are, therefore, suggested. Variance analysis reports prepared for the top management would obviously be more formal and would contain broad details only, while those meant for presentation to the lower levels would contain details showing the causes of each variance and the specific responsibilities of the individuals concerned.

Specimens of some variance analysis reports have been given in Figs. 12.4. to 12.8.

Variance Ratios and Cost Ratios. We have so far considered the various cost variances in absolute monetary terms. Although these show the extent of the variances, the information is insufficient if the management wants to study the trend of variances from period to period. Absolute figures in themselves do not give the full picture and it is only by comparison of one item with another that their correct relationship is obtained. Variance ratios serve this need and comparison of these ratios from one period to another can be gainfully made. Another advantage of variance ratio is in regard to its applicability in the dual plan of standard cost accounting (discussed later in this chapter). With the help of the cost variance ratios, standard costs of production and the standard values of inventory can be easily converted into actual costs for the purpose of incorporation in the financial accounts.

MATERIAL PRICE VARIANCE REPORT												
Name of Purchase Officer :					Date . or Week ending :							
Purchase Order No.	Invoice No.	Stores Receipt Voucher No.	Supplier	Item of material	Quantity purchased	Actual		Standard		Variance (F or A)		Analysis by causes
						Price per unit	Total	Price per unit	Total	Per unit	Total	
					Total							

Fig 12.4. Material Price Variance Report

MATERIAL USAGE VARIANCE REPORT									
Name of Department : Name of Foreman				Date or Week ending Shift No					
Material used (type of material)	Production Order No	Actual quantity	Standard quantity	Standard rate per unit	Variance				Analysis by causes
					Favourable		Adverse		
					Quantity	Cost	Quantity	Cost	
				Total					

Fig. 12.5. Material Usage Variance Report

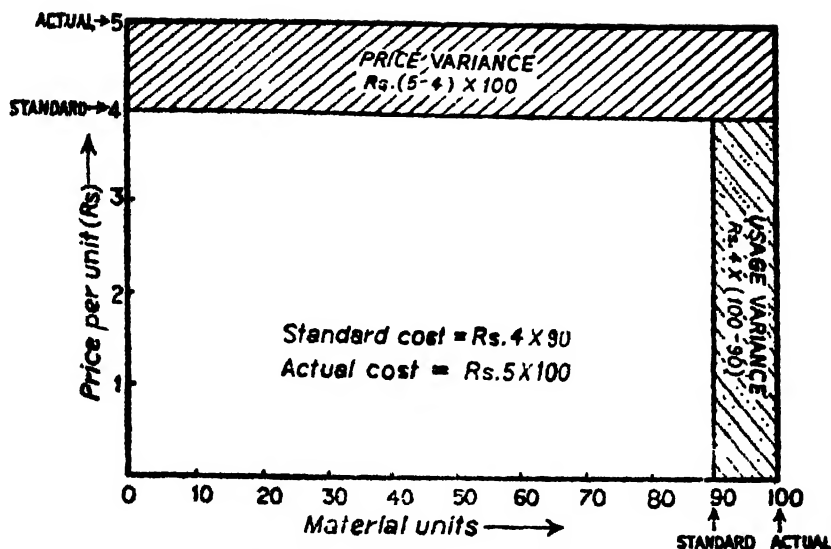


Fig. 12 8. Materials Variance Chart

A few examples of variances ratios and the various methods in use for determining them, are given below :

$$\begin{aligned} \text{Material price variance ratio} &= \frac{\text{Actual quantity} \times \text{Actual rate}}{\text{Actual quantity} \times \text{Standard rate}} = \frac{\text{Actual price}}{\text{Standard price}} \\ \text{Labour rate variance ratio} &= \frac{\text{Actual hours} \times \text{Actual rate}}{\text{Actual hours} \times \text{Standard rate}} = \frac{\text{Actual rate}}{\text{Standard rate}} \end{aligned}$$

[Rate/Price variance ratio is also calculated as follows :—

$$\begin{aligned} \text{Rate (or Price) variance ratio} &= \frac{\text{Rate (or Price) variance}}{\text{Total standard cost}}, \text{ or } \frac{\text{Difference in rates (or prices)}}{\text{Standard rates (or prices)}} \\ \text{Material usage variance ratio} &= \frac{\text{Actual quantity} \times \text{Standard rate}}{\text{Standard quantity} \times \text{Standard rate}} = \frac{\text{Actual quantity}}{\text{Standard quantity}} \\ \text{Labour efficiency variance ratio} &= \frac{\text{Actual hours} \times \text{Standard rate}}{\text{Standard hours} \times \text{Standard rate}} = \frac{\text{Actual hours}}{\text{Standard hours}} \end{aligned}$$

[Efficiency or usage variance ratio may also be computed as follows :—

$$\begin{aligned} \text{Efficiency variance ratio} &= \frac{\text{Efficiency variance}}{\text{Total standard cost}}, \text{ or } \frac{\text{Difference in quantities}}{\text{Standard quantities}} \\ \text{Material cost variance ratio} &= \text{Material price ratio} \times \text{Material usage ratio} \\ \text{Wages cost variance ratio} &= \text{Labour rate ratio} \times \text{Labour efficiency ratio} \end{aligned}$$

[Cost variance ratio may also be worked out as follows :—

$$\begin{aligned} \text{Cost variance ratio} &= \frac{\text{Price Variance} + \text{Efficiency variance}}{\text{Total standard cost}} \\ \text{Overhead expenditure ratio} &= \frac{\text{Actual overhead cost}}{\text{Budgeted overhead at actual level}} \\ \text{Volume variance ratio} &= \frac{\text{Standard cost in product}}{\text{Budgeted overhead cost}} \end{aligned}$$

(Volume variance ratio is also known as overhead utilisation ratio or capacity ratio)

A number of ratios are used for reporting to the management the effective use of capacity, material, labour and other resources of a concern. Some of these are considered below :

Efficiency ratio is the standard hours equivalent to the work produced, expressed as a percentage of the actual hours spent in producing that work.

$$\text{Efficiency ratio} = \frac{\text{Standard hours}}{\text{Actual hours}} \times 100$$

Activity ratio is the number of standard hours equivalent to the work produced, expressed as a percentage of the budgeted standard hours.

$$\text{Activity ratio} = \frac{\text{Standard hours for actual work}}{\text{Budgeted standard hours}} \times 100$$

Calendar ratio is the relationship between the number of working days in a period and the number of working days in the relative budget period.

$$\text{Calendar ratio} = \frac{\text{Available working days}}{\text{Budgeted working days}}$$

Capacity usage ratio is the relationship between the budgeted number of working hours and the maximum possible number of working hours in a budget period. This is expressed as,

$$\frac{\text{Budgeted hours}}{\text{Maximum possible hours in budget period}}$$

Capacity utilisation ratio is the relationship between actual hours in a budget period and the budgeted working hours in the period, and is expressed as,

$$\frac{\text{Actual hours}}{\text{Budgeted hours}}$$

The methods of calculation of these ratios are illustrated in the example given below :

EXAMPLE 12.7.

In Standard Costing, certain 'ratios' are used to illustrate the effective use of the resources of the company. By using the following figures, which are in respect of a four-week period calculate these ratios. In this period there was a special one day holiday due to national event.

Standard working	8 hours per day, 5 days per week
Maximum capacity	50 employees
Actually working	40 employees
Actual hours expected to be worked per four weeks	6,400 hours
Standard hours expected to be earned per four weeks	8,000 hours
Actual hours worked in the four-week period	6,000 hours
Standard hours earned in the four-week period	7,000 hours

(I.C.M.A., Pt. IV.—Adapted)

ANSWER :

Efficiency ratio	$\frac{\text{Standard hours}}{\text{Actual hours}} = \frac{7,000}{6,000}$	117%
Activity ratio	$\frac{\text{Standard hours}}{\text{Budgeted hours}} = \frac{7,000}{6,400}$	109%
Calendar ratio	$\frac{\text{Available working days}}{\text{Budgeted working days}} = \frac{(5 \times 4) - 1}{5 \times 4} = \frac{19}{20}$	95%
Capacity usage ratio	$\frac{\text{Budgeted hours}}{\text{Maximum possible hours in budget period}} = \frac{6,400}{8,000}$	80%
Capacity utilisation ratio	$\frac{\text{Actual hours}}{\text{Budgeted hours}} = \frac{6,000}{6,400}$	94%

Accounting of Standard Costs. Some concerns use standard costs for statistical purposes only. The best use of standard cost can, however, be made only if they are incorporated into the accounting system through journal and ledgers. Several methods of accounting for the operation of standard costs and for fitting them into the books of accounts are in use. Three basic types of accounting methods will be discussed here. As will be seen, each of the methods has certain advantages and limitations. The particular method selected for adoption in a concern will mostly be a matter to be decided by the cost accountant who will, no doubt, take into account the two main factors, viz. the utility of the method selected and the cost of its operation.

Method 1. Partial Plan

In this method (also known as the output method of compiling standard costs), the Work-in-Progress Account is debited with actual costs of materials, labour, and overhead and credited with standard costs of goods completed and transferred to the Finished Goods Account. Thus labour, material, and overhead costs as well as the inventory of raw materials are shown at actual costs, and the cost of goods sold and the inventory of finished and unfinished goods are shown at standard costs. The cost variances representing the differences between the debits and credits to the Work-in-Progress Account (or to three separate accounts, viz. Materials-in-Process, Wages-in-Process, and Overhead-in-Process Accounts) are worked out in totals only, at the end of the accounting period. Further analysis of the variances is made with the help of other additional information not recorded in the accounts.

The plan is illustrated in the chart in Fig. 12.9. The various steps involved in the plan may be summarised as follows :—

- (i) Establishment of standards for material, labour and overhead. This is done in advance before commencement of the accounting period.
- (ii) The costs incurred during the accounting period are recorded in actuals in the Wages Control, Stores Control and Overhead Control Accounts. Adjustment entries like depreciation, accrued expenses, etc. and transfer entries in respect of indirect material and labour costs from Stores Control and Wages Control Accounts to Overhead Control Accounts are made in actuals, at the end of the accounting period.
- (iii) The total actual amounts of materials consumed, wages paid, and overhead expenses incurred and accrued are transferred at the end of the accounting period, from the Stores Control, Wages control, and Overhead Control Accounts to the Work-in-Progress Account or to the three separate accounts, viz. Materials-in-Process, Wages-in-Process and Overhead-in-Process Accounts.
- (iv) If there is any work-in-progress (unfinished goods stock) at the end of the accounting period, it is evaluated at standard cost. The method of valuation of the unfinished stock is the same as applied in the case of process or job costing discussed previously, with the only difference that instead of actual costs, standard costs are used. Credit is thus given to the Work-in-Progress Account for the standard cost of unfinished goods and the amount is taken as the opening balance of unfinished goods stock in the next period.

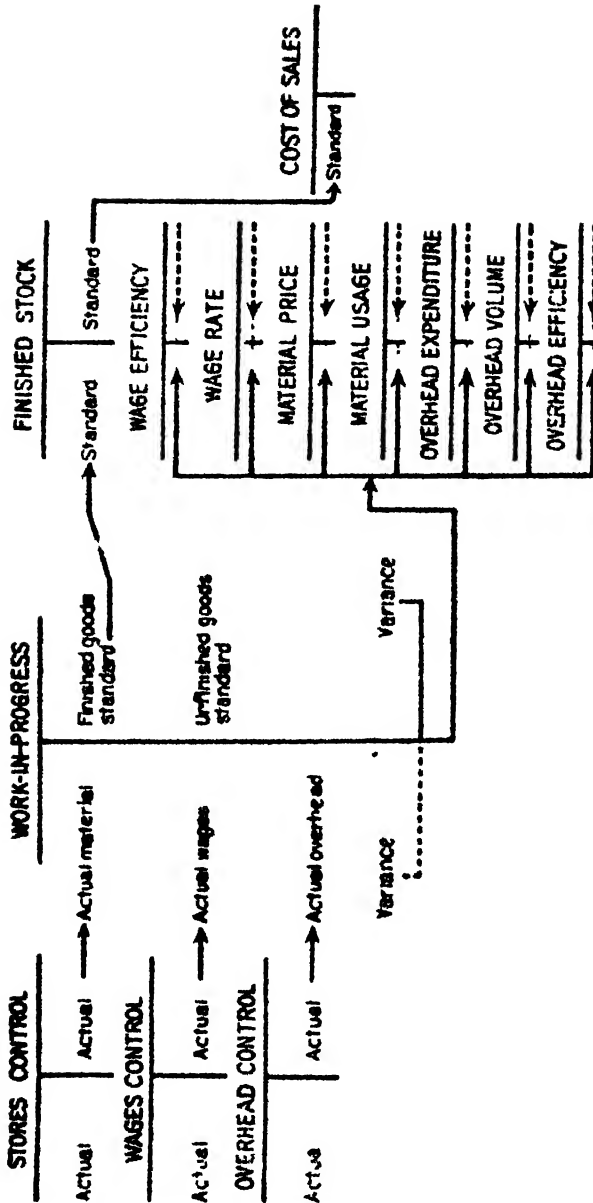


Fig 12.9. The Partial Plan

- (v) The finished goods or completed items of production are valued at standard costs by multiplying the units produced with the standard costs established. The standard cost of finished production is credited to the Work-in-Progress Account and debited to the Finished Stock Account. As goods are sold, the standard cost of the sold units is credited to the Finished Stock Account and debited to the Cost of Sales Account.
- (vi) The various types of cost variances are computed and suitably analysed for transfer to the respective variance accounts. This process now closes the Work-in-Progress Account.

- (vii) Each variance is disposed of by one of the methods discussed later and thus the variance accounts are closed.

The partial plan method involves less clerical expenditure but it is not widely applied as it has a number of *limitations*. These are :

- (i) Variances are computed only at the end of the accounting period after the stock of unfinished production has been taken. Such delayed computation impairs the effectiveness of control.
- (ii) The partial plan is suitable only in cases where variances are not many so that the delay in their analysis does not have any material effect.

Method 2. Single Plan

In this method, also known as the input method of compiling standard costs, both debits and credits are made to the Work-in-Progress Account at standard costs. Variances may be computed whenever required and analysed with the help of information available from subsidiary records such as materials requisitions, job cards etc. on the basis of costs inputs, i.e. as the costs are incurred.

A chart of the accounting system under this method may be seen in Fig. 12.10. The various steps involved in this method are described below :

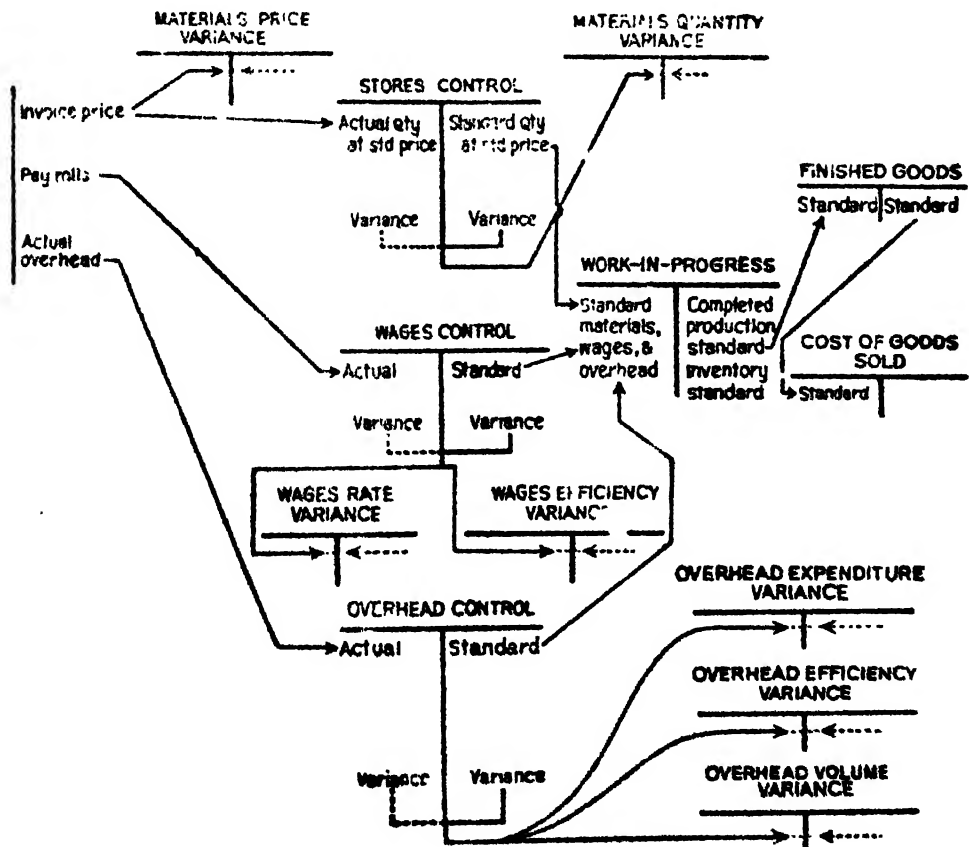


Fig. 12.10. The Single Plan

- (i) Standard costs for material, labour and overhead are set.

- (ii) Materials purchased are debited to Stores Control Account at actual quantity at standard price. The difference between the amount debited and the actual cost represents the material price variance which is charged to the Material Price Variance Account. The computation of this variance is made periodically, usually as and when purchases are made.
- (iii) When materials are issued to production, Stores Control Account is credited and the Work-in-Progress Account debited with the standard quantity issued at standard price. The difference arising in the Stores Control Account is the material usage variance which is charged to the Material Usage Variance Account. This analysis is done on a day-to-day basis. The stores inventory in the Store Control Account is maintained at standard costs although in some concerns this is converted into actual costs. The relative merits of the two methods have been discussed later.
- (iv) Wages Control Account is debited with the amount of actual wages paid, and credited with the standard wages cost by corresponding debit to Work-in-Progress Account. The difference representing the wages variance is suitably analysed into labour rate variance and labour efficiency variance, and charged to the appropriate variance account.
- (v) Overhead Control Account is debited with the actual overhead cost and credited with the standard overhead at standard rates. The latter amount is debited to the Work-in-Progress Account. The balance in the Overhead Control Account, which represents the overhead variance, is analysed and charged to the various overhead variance accounts. The overhead variances can be calculated only at the end of the accounting period.
- (vi) All variances having been segregated before debit to Work-in-Progress Account, the finished stock and the work-in-progress (incomplete or unfinished stock) are priced at standard costs. Transfers to Finished Stock Account and Cost of Sales Account are made at standard costs.

An example is given below to further illustrate the single plan.

EXAMPLE 12.8.

Standard quantities and variable costs of a simple sheet steel box are as follows :

Material :	1.5m. x 1m. x 16g. Sheet steel	Rs. 15.00
Wages :	2½ hours at Re. 1 per hour	Rs. 2.50
Variable overhead :	2½ hours at Rs. 1.50 per hour	Rs. 3.75
Total standard cost		Rs. 21.25

Standard variable overhead cost for November is Rs. 15,000.

Standard direct labour hours for the budgeted output of 4,000 boxes are 10,000 hours.

Sales value for this output is Rs. 1,00,000.

The following details apply to November :

Materials :	(a) purchased : 5,000 sheets at Rs. 16 per sheet, each 1.5m. x 1m. x 16g.
	(b) issue to production : 4,400 sheets each 1.5m. x 1m. x 16g.
Wages :	10,200 hours at Rs. 1.25 per hour
Variable overhead :	Rs. 16,400

Production : Finished : 4,000 boxes, In progress : 400 boxes (finished as regards material cost ; one half finished as regards wages and variable overhead.)

Invoiced despatches : 3,900 boxes at Rs. 25 each

Determine variances, and present journal entries to cover the activities of the month, using standard values when debiting or crediting work-in-progress accounts and valuing stocks.

(I.C.M.A., Pt. IV—Adapted)

ANSWER :

Dr. Stores Ledger Control Account	Rs. 75,000	
Dr. Material Price Variance Account	Rs. 5,000	
Cr. Sundry Creditors		Rs. 80,000

(Purchase made : determination of material price variance)

Dr. Work-in-Progress Account	Rs. 66,000	
Cr. Stores Ledger Control Account		Rs. 66,000

(Issue made)

(Note : There is no material usage variance)

Dr. Wages Control Account	Rs. 12,750	
Cr. Wages Payable		Rs. 12,750

(Actual wages paid)

Dr. Work-in-Progress Account	Rs. 10,500	
Dr. Wage Rate Variance Account	Rs. 2,250	
Cr. Wages Control Account		Rs. 12,750

Cr. Labour Efficiency Variance Account		Rs. 300
--	--	---------

(Allocation of wages and calculation of wages variance)

The wages variances are determined as follows :

Wages rate variance = 10,200 hours \times Re. 0.25 = Rs. 2,550 (Adv)

Labour efficiency variance = 300 hours \times Re. 1 = Rs. 300 (Fav)

Dr. Variable Overhead Control Account	Rs. 16,000	
Cr. Sundry Creditors		Rs. 16,000

(Actual variable overhead costs incurred)

Dr. Work-in-Progress Account	Rs. 15,750	
Cr. Variable Overhead Applied Account		Rs. 15,750

(Standard overheads charged to work-in-progress,
4,200 boxes \times 2½ hrs. \times Rs. 1.50)

[The difference between actual overhead costs (Rs. 16,000) and the standard overhead charged to work-in-progress (Rs. 15,750) represents an adverse overhead expenditure variance]

Dr. Finished Stock Account	Rs. 86,000	
Cr. Work-in-Progress Account		Rs. 86,000

(Transfer of 4,000 boxes produced at standard cost)

Dr. Sundry Debtors	Rs. 97,500	
Cr. Sales		Rs. 97,500

(Sales of 3,900 boxes at Rs. 25 each)

Cost of production in progress (400 incomplete boxes) is calculated at standard, as follows :

	Rs.
Complete material (Rs. 15 \times 400)	6,000
Half-complete labour (Rs. 2.50 \times 400 \times ½)	500
Half-complete variable overhead (Rs. 3.75 \times 400 \times ½)	750
	<u>Rs. 7,250</u>

The main *advantages* of the single plan are as follows :—

- (i) Cost variances are promptly revealed.
- (ii) Analysis of variances may be done in as much detail as possible.
- (iii) Operation of the method is simple and economical.

The *limitations* of this method and the criticism levelled against it are as follows :—

- (i) When a large number of products are involved, it is difficult to allocate variations to each product with accuracy.

- (ii) Unless the standards are correct and up-to-date, the standard costs of products are unreliable and misleading.
- (iii) This is not applicable in case of cost plus contracts.

Method 3. Dual Plan

The main feature of this method is that debits and credits to the Stores, Work-in-Progress and Finished Stock Control Accounts are made at both actual and standard costs, which are entered in two parallel columns in the ledger. The Cost of Sales Account and the financial statements record only the actual costs. Another characteristic of the dual plan is that the variances are computed as percentages and not in absolute monetary terms. The dual plan provides the same amount of information and the same degree of variance analysis as the single plan but the basic difference between the two methods is that in the dual plan, standard costs are considered to be only tools of control and are not carried to financial statements.

The main *advantage* of the dual plan lies in the fact that it shows trends in performances and measures the degree-of variation from standards.

The *demerits* of the method are as follows :—

- (i) Computation of variances is complicated and time taking.
- (ii) It involves more clerical work as two parallel sets of figure are to be recorded in the accounts.
- (iii) Variance analysis is not provided as promptly as in the single plan.

Treatment of Cost Variances in Accounts. In standard cost accounting system which contain both actual and standard costs in the accounting records and financial statements, the question of adjustment of the cost variances at the end of the accounting period arises. Three methods of disposal of variances and the advantages and disadvantages of each are discussed below :

(i) **Transfer to Profit and Loss Account :** In this method, the stocks of work-in-process and finished goods and cost of sales are maintained at standard costs and all variances are closed to the Profit and Loss Account at the end of the accounting period.

The arguments advanced in favour of transfer of variances to profit or loss are :

- (a) Standard costs are considered to be the correct or real costs. Any variances from the standard costs should, therefore, be taken to mean deviations from the 'should be' costs due to efficiencies or inefficiencies, abnormal activity, excessive or less spending, etc. The variances cannot, therefore, be considered as the normal increases or decreases in costs and should be debited or credited to the Profit and Loss Account.
- (b) The method ensures conservative inventory valuation as all extraneous factors like costs of inefficiencies, waste, and losses are eliminated.
- (c) Exclusion of variations makes gross profit for different periods comparable.
- (d) Standard costs facilitate prompt inventory valuation.
- (e) Variances separated out and reflected as profit or loss attract the management's attention.
- (f) Distribution of variances to product costs is difficult where a large number of diverse products is manufactured.

Some accountants prefer to transfer only the debit variances and no credit variances to the Profit and Loss Account. Another practice is to adjust a proportionate part of the material price variance to the closing stock of materials when price variance at the point of purchase is worked out, as illustrated below :

Purchase of materials	Rs. 10,000
Closing stock of materials	Rs. 1,000
Material price variance (debit)	Rs. 200
Variance transferred to closing stock	$\frac{\text{Rs. 1,000}}{\text{Rs. 10,000}} \times \text{Rs. 200} = \text{Rs. 20}$

Variance charged to Profit and Loss Account - Rs. 180

The closing stock of material will be shown in the Balance Sheet at Rs. 1,020

(ii) *Allocation of variances to Finished Stock, Work-in-Progress and Cost of Sales Account* : Under this method, the variances are distributed over stocks of finished and partly finished products and to the cost of sales. The distribution of each variance is made to the three accounts on a percentage basis according to the closing balance (value) of each account.

The allocation method has the effect of recording actual costs in the financial statement. It should be noted that the adjustments to the various accounts are made in the general ledger only and subsidiary accounts and records are not adjusted. In the balance sheet, the adjustments may, however, be shown separately if so desired. While distributing the variances, allocation to the various products should not be attempted as the separation and analysis of variances are meant for cost control and not for finding product costs. The arguments put forth in support of this method are, in brief, as follows :—

- Standard costs are only tools of control and they do not represent true or correct costs. Only actual costs should, therefore, be reflected in the financial statements.
- Variances are not actual losses and as such, they should not be allowed to distort profits.
- Unless the standards are accurate and up-to-date, inventory valuation on the basis of standard costs will be inaccurate.
- Variances when credited to the Profit and Loss Account inflate the Work-in-Progress Account to the extent of the unrealised profit.

Sometimes, the variances are partly transferred as profit or loss and partly allocated. Usually, large uncontrollable variances like material price variances which arise due to price fluctuations would be allocated to the inventory of stores, work-in-progress and finished stock, while small controllable variances are closed to Profit and Loss Account. The latter procedure is followed to adjust under- or over-absorbed overhead even when no standard cost system is in use.

(iii) *Transfer of variances to the Reserve Account* : In this method, the various cost variances are carried over to the subsequent financial year as deferred credit or charges. Thus, variance losses and gains may be set off against the gains and losses in the subsequent years. This method is not in common use but it might be useful in cases where seasonal fluctuations occur so that the favourable and adverse variances may cancel each other in a complete business cycle covering more than one financial year.

Pricing of Closing Work-in-Progress and Finished Stock in Standard Costing System. The function of balance sheet is to give a true and fair view of the state of affairs of a company on a particular date. A true and fair view also implies the consistent application of generally accepted principles. If stocks are kept at standard costs consistently and uniformly from year to year and the standard costing system is functioning efficiently, no problem arises. But stocks valued at standard costs are required to be adjusted at actual costs in the following circumstances :—

- (a) Opening stock was valued at actual costs. (Unless the same basis is adopted consistently from period to period, the accounts will not give a true and fair view of the trend of trading results.)
- (b) The standard costing system introduced is still in an experimental stage and the variances merely represent deviations from poorly set standards.
- (c) Occurrence of certain variances which are beyond the control of the management. (Unless the stocks are adjusted for uncontrollable factors, the values are not correctly stated.)

Maintenance of Raw Material Stock at Standard Cost. In the single plan, the inventory in the stores ledger may be carried either at standard costs or at actuals. Although both the methods are in use, the consensus is in favour of standard costs. The *advantages* of adopting standard costs for inventory valuation are as follows :—

- (i) Stores ledger may be maintained in quantities only and the standard price noted at the top in the ledger sheets. This economises the use of forms as well as reduces clerical costs as no columns for rates need be maintained.
- (ii) Pricing of materials requisitions is simplified as only one standard price for each item of material is required to be used.
- (iii) Price variance is promptly revealed at the time of purchase of materials.

The *disadvantages* are :

- (i) The stores ledger does not reveal the current prices.
- (ii) If the material stock is shown in the balance sheet at standard costs, the variances have the effect of distorting the profit or loss. Standard cost of the closing inventory is required to be adjusted to actual cost based on price variance to comply with the statutory requirement of the Companies Act.
- (iii) A revision of the standard necessitates revision of the cost of the inventory.

Operating Statements in Standard Costing System. When accounts are maintained at standard cost, the presentation of the overall results of performance is required to be made with special care. As profits are to be shown at actuals only, the standard costs are converted into actual costs by adding or subtracting the variances. The form of presentation would vary in details according to the type of standard costing system in use. Two such forms suitable for presenting operating statements are illustrated in Figs. 12.11. and 12.12.

OPERATING STATEMENT

	Period :	
	Rs.	Rs.
Sales (Actual)		
Cost of sales (Standard)		50,000
Direct materials	10,000	
Direct labour	12,000	
Factory overhead	15,000	
Gross Profit (Standard)		37,000
Add Favourable variances :		13,000
Material usage		
Wage rate	400	
Labour usage	250	
Overhead efficiency	100	
	50	
	--	800
		13,800
Deduct Adverse variances		
Material price	00	
Overhead expenditure	150	
Overhead volume	300	
		650
Gross Profit (Actual)		13,150
Selling and distribution overhead (Actual)		6,150
Net Profit (Actual)		Rs. 7,000

Fig. 12.11. Operating Statement (Form 1)

Note : Favourable variances are added to and adverse variances deducted from the standard gross profit to arrive at the actual gross profit.

OPERATING STATEMENT

	Period :	
	Rs.	Rs.
Sales (Actual)		Rs. 50,000
Cost of Sales :		
Direct materials (Standard)	10,000	
Add material price variance (A)	200	
Less material usage variance (F)	(-) 400	
Direct labour (Standard)	12,000	
Less wages rate variance (F)	(-) 250	
Less labour efficiency variance (F)	(-) 100	
Factory overhead (Standard)	15,000	
Add overhead expenditure variance (A)	150	
Add overhead volume variance (A)	300	
Less overhead efficiency variance (F)	(-) 50	
		Rs. 36,850
Gross Profit (Actual)		Rs. 13,150
Selling and distribution overhead (Actual)		Rs. 6,150
Net Profit (Actual)		Rs. 7,000

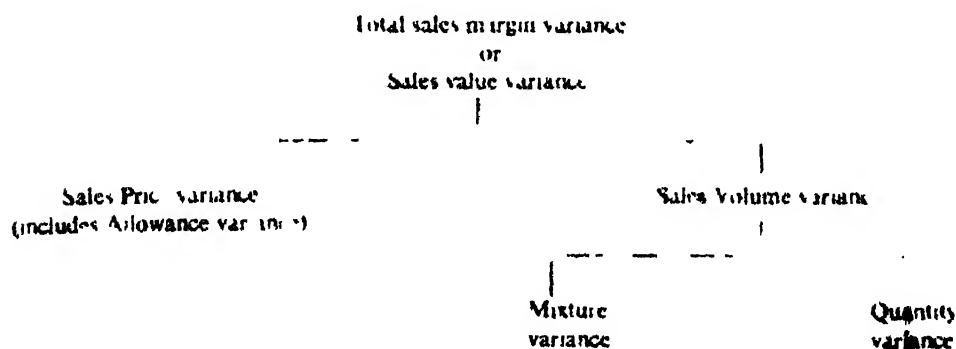
Fig. 12.12. Operating Statement (Form 2)

Note : Adverse variances are added to and favourable variances deducted from the standard costs to arrive at the actual costs.

Computation and Analysis of Profit and Sales Variances. Deviation of the actual profit or loss from the planned or budgeted profit or loss causes a profit (or loss) variance. Profit variance arises due to (i) change in costs, i.e. variance in the standard cost of sales, (ii) change in the sales value, i.e. sales variances consequent upon variances in selling prices, sales volume, sales mixture, or sales allowances, and (iii) other variances not included in the above categories, such as those pertaining to research and development, etc. Each of these causes should be suitably analysed so that the control, if not effective, may be tightened, or alternatively, the plan itself may be adjusted in tune with the changing conditions. Variances relating to cost of sales which comprise direct materials, direct labour, overhead and selling and distribution costs variances, were dealt with earlier. Sales variance and its constituent sub-variances will be discussed in the following sections.

Sales variance (also called *sales value or sales revenue variance*) is the difference between budgeted value of sales and the actual value of sales achieved in a given period. Sales variance can be analysed in many ways to suit a particular business, e.g. to isolate the effects of price changes, discounts and allowances from the effect of differing quantities of sales. A distinction is sometimes drawn between quantity and mixture variances. A mixture variance which is based on sales values only may be misleading because the effect of selling a different product mix than was budgeted is not only the difference in sales values but also the difference in standard cost of the mixture. In other words, it is a difference in sales margins.

Sales variances may be analysed as sales margin variances (i.e. on the basis of margin or profit) or as simple sales variances based on turnover.



The analysis of the variances is illustrated below

Data assumed

	Standard or Budgeted		Actual	
	Product A	Product B	Product A	Product B
Quantity of sales (units)	100	140	110	140
Selling price per unit	Rs. 10	Rs. 20	Rs. 8	Rs. 19.5
Cost of sales per unit	Rs. 7	Rs. 18	Rs. 7	Rs. 18
Margin or Gross profit per unit	Rs. 3	Rs. 2	Rs. 1	Rs. 1.5

(As cost variances are not being considered, the standard and actual costs have been assumed to be identical.)

A. Variances based on profits

Total sales margin variance : This is an overall or composite variance made up of other sub-variances, and is represented by the difference between the standard margin appropriate to the quantity of sales budgeted for a period and the margin between standard cost and the actual selling price of the sales effected.

Total sales margin variance = Standard or budgeted margin <i>minus</i> Actual margin							
A	100 × Rs. 3	110	Rs. 1	Rs. 300	Rs. 110	Rs. 190 (A)	
B	150 × Rs. 2	140	Rs. 1.5	Rs. 300	Rs. 210	Rs. 90 (A)	
							Rs. 280 (A)

(As the actual margin is less, the variance is adverse.)

Sales margin variance due to selling price : This is that portion of total margin variance which is due to the difference between the standard price of the quantity of sales effected and the actual price of those sales.

Sales price variance = Actual quantity of sales × Standard price <i>minus</i> Actual quantity of sales × Actual price							
A	110 × Rs. 10	110 × Rs. 8	-	Rs. 1,100	Rs. 880	Rs. 220 (A)	
B	140 × Rs. 20	140 × Rs. 19.5	-	Rs. 2,800	Rs. 2,730	Rs. 70 (A)	
							Rs. 290 (A)

(Actual sales at actual price being less than sales at standard price variance is adverse.)
Another formula is as follows :

Sales price variance = Profit on actual sales at standard price and standard cost <i>minus</i> Actual profit							
For product A price variance = 110 (Rs. 10 - Rs. 8) - 110 (Rs. 8 - Rs. 7)							
							Rs. 220 (A)

(This formula gives the same result as the previous one, and may be more appropriately used when the actual cost is different from the standard cost.)

Sales margin variance due to volume of sales : This is that portion of total margin variance which is due to the difference between the budgeted quantity and the actual quantity of sales. The variance is composed of two sub-variances, viz. due to change in the ratio of quantities of sales (mix variance) and actual sales being more or less than the budgeted sales (quantity variance).

Sales volume variance = Standard profit on standard quantity of sales <i>minus</i> Standard profit on actual quantity of sales.							
A	100 × Rs. 3	110 × Rs. 3	=	Rs. 300	-	Rs. 330	= Rs. 30 (F)
B	150 × Rs. 2	140 × Rs. 2	=	Rs. 300	-	Rs. 280	= Rs. 20 (A)
							Rs. 10 (F)

(Excess of actual sales over standard sales indicates a favourable variance.)

Another formula is :

Sales volume variance = Standard profit <i>minus</i> Profit on actual sales at standard price and standard cost							
For product A, volume variance = 100 (Rs. 10 - Rs. 7) - 110 (Rs. 10 - Rs. 7)							
							= Rs. 30 (F)

Sales margin variance due to sales mixture : This is that portion of total margin variance which is due to the difference between the budgeted and actual quantities of each product of which the sales mixture is composed, valuing sales at the standard net selling prices and cost of sales at standard.

Sales mixture variance = Standard margin \times (standard proportion for actual sale *minus* actual proportion)

	Actual proportion	Standard proportion
A	110	$\frac{100}{250} \times 250 = 100$
B	$\frac{140}{250}$	$\frac{150}{250} \times 250 = 150$

Sales mixture variance

A	Rs. 3 (100 - 110) = Rs. 30 (F)
B	Rs. 2 (150 - 140) = Rs. 20 (A)

Rs. 10 (F)

(Margin from actual sales expressed in standard proportion being more than budgeted sales, the variance is favourable.)

Another formula for calculating sales mixture variance is as follows :—

Sales mixture variance = Standard sales units \times Weighted budgeted margin per unit *minus* Margin of actual sales units at standard price

A	$100 \times \frac{250}{250} \times \text{Rs. } 3 - 110 \times \text{Rs. } 3 = \text{Rs. } 300 - \text{Rs. } 330 = \text{Rs. } 30 \text{ (F)}$
B	$150 \times \frac{250}{250} \times \text{Rs. } 2 - 140 \times \text{Rs. } 2 = \text{Rs. } 300 - \text{Rs. } 280 = \text{Rs. } 20 \text{ (A)}$

Rs. 10 (F)

Sales margin variance due to sales quantities : This is that portion of the sales volume variance which arises due to the difference in the total actual and the budgeted sales.

Sales quantity variance = Standard margin \times (Budgeted sales *minus* Standard proportion for actual sales)

A	Rs. 3 (100 - 100) = 0
B	Rs. 2 (150 - 150) = 0
	0

Sales margin variances due to sales allowances : This is that portion of total margin variance which is due to the difference between the budgeted rebates, discounts, etc. on the sales effected and the actual rebates, discounts, etc. allowed on those sales. Sales allowances are, in effect, reductions in sales price. The sales allowances variance may, therefore, be calculated by evaluating and deducting the difference of the allowances between actual and standard from the price variance.

(No data for allowances have been given in the illustration.)

Reconciliation of profit would be as follows :—

Budgeted profit		Rs. 600
Deduct Price variance		Rs. 290 (A)
Add Mix variance	Rs. 10 (F)	
Quantity variance	—	
Volume variance	Rs. 10 (F)	
Actual profit		Rs. 320

B. Variance based on turnover

Sales value variance : Difference between actual values of sales for the period and predetermined standard value of sales for that period. (Actual quantity \times Actual selling price) — (Standard quantity \times Standard selling price)

	Actual sales Rs.	Budgeted sales Rs.	Variance
A	880	1,000	Rs. 120 (A)
B	2,730	3,000	Rs. 270 (A)
	<hr/> Rs. 3,610	<hr/> Rs. 4,000	<hr/> Rs. 390 (A)

Sales price variance : Difference between actual selling price per unit and the actual quantity sold at standard selling price per unit.
(Actual selling price - Standard selling price) \times Actual quantity

	Actual sales at budgeted price Rs.	Actual sales Rs.	Variance Rs.
A	1,100	880	Rs. 220 (A)
B	2,800	2,730	Rs. 70 (A)
	<hr/> Rs. 3,900	<hr/> Rs. 3,610	<hr/> Rs. 290 (A)

Sales volume variance : Difference between actual quantity sold at standard price per unit and standard quantity at standard price per unit (Actual quantity \times Standard price - Standard quantity \times Standard price)

	Actual sales at budgeted price Rs.	Budgeted sales Rs.	Variance
A	1,100	1,000	Rs. 100 (F)
B	2,800	3,000	Rs. 200 (A)
	<hr/> Rs. 3,900	<hr/> Rs. 4,000	<hr/> Rs. 100 (A)

Actual sales at budgeted price when rearranged in the budgeted ratio will be :

A	$\frac{100 \times 10}{4,000} \times 3,900 = \text{Rs. } 975$
B	$\frac{150 \times 20}{4,000} \times 3,900 = \text{Rs. } 2,925$
	<hr/> Rs. 3,900

Sales quantity variance :

	Actual sales at budgeted price in budgeted ratios Rs.	Budgeted sales Rs.	Variance
A	975	1,000	Rs. 25 (A)
B	2,925	3,000	Rs. 75 (A)
	<hr/> Rs. 3,900	<hr/> Rs. 4,000	<hr/> Rs. 100 (A)

Sales mixture variance : Difference between the actual quality sold and the standard proportion multiplied by the standard selling price.

	Actual sales	Actual sales at budgeted price in budgeted ratios	Variance
	Rs.	Rs.	
A	1,100	975	Rs. 125 (F)
B	2,800	2,925	Rs. 125 (A)
	<u>Rs. 3,900</u>	<u>Rs. 3,900</u>	<u>Nil</u>

It will be seen that the total mixture variance is nil so that when profit is not being considered, the total sales volume variance is comprised of only quantity variance. This is because of the fact that although the sales mix is changed, the total of the actual sales rearranged in the budgeted ratios is equal to the total actual sales in the actual proportion.

Some illustrations are given below to further explain sales variances :

EXAMPLE 12.9

You are required to prepare a sales variance analysis statement in respect of a company selling three products with the help of the following data

Product	Budgeted		Actual	
	Sale price	Sale units	Sale price	Sale units
	Rs.		Rs.	
1	5	5,000	6	6,000
2	8	8,000	9	7,000
3	10	6,000	9	3,000
		<u>19,000</u>		<u>21,000</u>

ANSWER :

Sales variance analysis statement

Product	Budgeted			Actual			Variance	
	Qty. (units)	Rate (Rs.)	Amount (Rs.)	Qty. (units)	Rate (Rs.)	Amount (Rs.)	Volume (Rs.)	Price (Rs.)
1	5,000	5	25,000	6,000	6	36,000	5,000	6,000
2	8,000	8	64,000	7,000	9	63,000	(-), 8,000	7,000
3	6,000	10	60,000	8,000	9	72,000	20,000	(-), 8,000
			<u>Rs. 1,49,000</u>			<u>Rs. 1,71,000</u>	<u>17,000</u>	<u>5,000</u>
							<u>Rs. 22,000</u>	

Volume Variance : (Actual volume—Budgeted volume) × Budgeted rate

1. $(6,000 - 5,000) \times \text{Rs. } 5 = \text{Rs. } 5,000 \text{ (F)}$
2. $(7,000 - 8,000) \times \text{Rs. } 8 = \text{Rs. } 8,000 \text{ (A)}$
3. $(8,000 - 6,000) \times \text{Rs. } 10 = \text{Rs. } 20,000 \text{ (F)}$

Rs. 17,000 (F)

Price Variance : (Actual rate—Budgeted rate) × Actual quantity

1. $(\text{Rs. } 6 - \text{Rs. } 5) \times 6,000 = \text{Rs. } 6,000 \text{ (F)}$
2. $(\text{Rs. } 9 - \text{Rs. } 8) \times 7,000 = \text{Rs. } 7,000 \text{ (F)}$
3. $(\text{Rs. } 9 - \text{Rs. } 10) \times 8,000 = \text{Rs. } 8,000 \text{ (A)}$

Rs. 5,000 (F)

EXAMPLE 12.10.

From the following budgeted and actual figures calculate and present the variances in respect of Profit, Sales and Cost of Sales.

<i>Budget</i>		Rs
Sales—2,000 units @ Rs 15 each		30,000
Cost of sales @ Rs 12 each		24,000
		<u>6,000</u>
<i>Actual</i>		Rs
Sales 1,900 units @ Rs 14 each		26,600
Cost of sales @ Rs 10 each		19,000
Profit		<u>7,600</u>

(I.C.W.A., Inter)

ANSWER

1. Profit variance

	Rs
Budgeted profit	Rs 6,000
Actual profit	Rs 7,600
Profit variance	Rs 1,600(F)

2. Sales variance

<i>Budgeted</i>			<i>Actual</i>		
Qty (units)	Rate (Rs)	Amount (Rs)	Qty (units)	Rate (Rs)	Amount (Rs)
2,000	15	30,000	1,900	14	26,600
Quantity variance		(2,000 - 1,900) × Rs 15			Rs 1,500(A)
Price variance		1,900 × (Rs 15 - Rs 14)			Rs 1,900(A)
Sales variance					<u>Rs 3,400(A)</u>

3. Cost of sales variance

<i>Budgeted</i>			<i>Actual</i>		
Qty (units)	Cost (Rs)	Amount (Rs)	Qty (units)	Cost (Rs)	Amount (Rs)
2,000	12	24,000	1,900	10	19,000
Volume variance		(2,000 - 1,900) × Rs 12			Rs 1,200(F)
Cost variance		1,900 × (Rs 12 - Rs 10)			Rs 3,800(F)

Cost of sales variance = Rs 24,000 - Rs 19,000 = Rs 5,000(F)

Profit variance = Sales variance + cost of sales variance

= Rs 3,400(A) + Rs 5,000(F) = Rs 1,600(F)

Alternatively, the variances can be calculated on Profit margin (or sales margin) basis

<i>Budgeted</i>			<i>Actual</i>		
Qty (units)	Profit margin (Rs)	Amount (Rs)	Qty (units)	Profit margin (Rs)	Amount (Rs)
2,000	15 - 12 = 3	6,000	1,900	14 - 10 = 4	7,600
Quantity variance		(2,000 - 1,900) × Rs 3			- Rs 300(A)
Profit margin variance		1,900 × (Rs 3 - Rs 4)			- Rs 1,900(F)
Profit variance					<u>- Rs 1,600(F)</u>

EXAMPLE 12.11.

Modern Toys Ltd. had budgeted the following sales for a month .

Toy A	900 units @ Rs 50 per unit
Toy B	650 units @ Rs. 100 per unit
Toy C	1,200 units @ Rs 75 per unit

As against this, the actual sales were :

Toy A	1,000 units @ Rs. 55 per unit
Toy B	700 units @ Rs. 95 per unit
Toy C	1,100 units @ Rs. 78 per unit

The costs per unit of A, B, and C were Rs. 45, Rs. 85 and Rs. 65 respectively.

Compute the different variances to explain the difference between the budgeted and actual profits. (I.C.W.A., Final)

ANSWER :

Budgeted

Product	Sales			Cost of sales		Gross profit	
	Units	Unit price Rs.	Amount Rs.	Per unit Rs.	Amount Rs.	Per unit Rs.	Amount Rs.
A	900	50	45,000	45	40,500	5	4,500
B	650	100	65,000	85	55,250	15	9,750
C	1,200	75	90,000	65	78,000	10	12,000
	2,750		Rs. 2,00,000		Rs. 1,73,750		Rs. 26,250

Weighted budgeted gross profit per unit = $\frac{\text{Rs. } 26,250}{\text{Rs. } 2,750} = \text{Rs. } 9.545$

Actual

A	1,000	55	55,000	45	45,000	10	10,000
B	700	95	66,500	85	59,500	10	7,000
C	1,100	78	85,800	65	71,500	13	14,300
	2,800		Rs. 2,07,300		Rs. 1,76,000		Rs. 31,300

Actual sales at budgeted price

Product	Sales			Cost of sales		Gross profit	
	Units	Unit price Rs.	Amount Rs.	Per unit Rs.	Amount Rs.	Amount Rs.	
A	1,000	50	50,000	45	45,000		5,000
B	700	100	70,000	85	59,500		10,500
C	1,100	75	82,500	65	71,500		11,000
	2,800		Rs. 2,02,500		Rs. 1,76,000		Rs. 26,500

Standard proportion of margin for actual sales

A	$1,000 \times \text{Rs. } 9.545 = \text{Rs. } 9,545$
B	$700 \times \text{Rs. } 9.545 = \text{Rs. } 6,682$
C	$1,100 \times \text{Rs. } 9.545 = \text{Rs. } 10,500$
	Rs. 26,727

The variances are calculated as follows :—

Total sales margin variance

	Standard profit Rs.	Actual profit Rs.	Variance
A	4,500	10,000	Rs. 5,500(F)
B	9,750	7,000	Rs. 2,750(A)
C	12,000	14,300	Rs. 2,300(F)
	Rs. 26,250	Rs. 31,300	Rs. 5,050(F)

Sales margin variance due to price

	Profit on actual sales at budgeted price	Actual profit	Variance
	Rs.	Rs.	
A	5,000	10,000	Rs. 5,000(F)
B	10,500	7,000	Rs. 3,500(A)
C	11,000	14,300	Rs. 3,300(F)
	<hr/>	<hr/>	
	Rs. 26,500	Rs. 31,300	Rs. 4,800(F)

Sales margin variance due to volume

	Standard profit	Profit on actual at budgeted price	Variance
	Rs.	Rs.	
A	4,500	5,000	Rs. 500(F)
B	9,750	10,500	Rs. 750(F)
C	12,000	11,000	Rs. 1,000(A)
	<hr/>	<hr/>	
	Rs. 26,250	Rs. 26,500	Rs. 250(F)

Sales margin variance due to sales mix

	Weighted budgeted profit on actual sales	Profit on actual sales at budgeted price	Variance
	Rs.	Rs.	
A	9,545	5,000	Rs. 4,545(A)
B	6,682	10,500	Rs. 3,818(F)
C	10,500	11,000	Rs. 500(F)
	<hr/>	<hr/>	
	Rs. 26,727	Rs. 26,500	Rs. 227(A)

Sales margin variance due to sales quantities

	Budgeted profit	Weighted budgeted profit on actual sales	Variance
	Rs.	Rs.	
A	4,500	9,545	Rs. 5,045(F)
B	9,750	6,682	Rs. 3,068(A)
C	12,000	10,500	Rs. 1,500(A)
	<hr/>	<hr/>	
	Rs. 26,250	Rs. 26,727	Rs. 477(F)

Profit variance analysis statement

Budgeted profit		Rs. 26,250
Add Favourable variances		
Sales price		Rs. 4,800(F)
Sales volume		
Quantity	Rs. 477(F)	
Mixture	Rs. 227(A)	
	<hr/>	Rs. 250(F)
		<hr/>
		Rs. 5,050
		<hr/>
Actual profit		Rs. 31,300
		<hr/>

The following example illustrates the analysis of profit variance taking data for a previous period as the yardstick instead of standards.

EXAMPLE 12.12.

Despite the increase in the sale price of its sole product to the extent of 20%, a company finds that it has incurred loss during the year 1978 to the extent of Rs. 4 lakhs as against the profit of Rs. 5 lakhs made in 1977. The adverse situation is attributed mainly to the increase in price of materials and overhead the increase over the previous year being on the average, 15% and 10% respectively.

The following figures are extracted from the books of the company :

	31.3.77 Rs.	31.3.78 Rs.
Sales	1,20,00,000	1,29,60,000
Cost of Sales :		
Material	80,00,000	91,10,000
Variable overhead	20,00,000	24,00,000
Fixed overhead	15,00,000	18,50,000

You are required to analyse the variances over the year in order to bring out the reasons for the fall in profit
(I C W A Final)

ANSWER :

(All amounts in the answer have been expressed in Rs. lakh)

(i) Sales variance

Sales during 1977-78 at the previous year's level of price

$$129.60 - \frac{20}{120} \times 129.60 = 108.00$$

Sales price variance = $129.60 - 108.00 = 21.60(F)$ (1)

Decrease in sales = $120.00 - 108.00 = 12.00$, or
= 10% of 1976-77 sales

Contribution at 1976-77 rate = $120.00 - 100.00 = 20.00$ or,
= $20/120 = \text{Rs. } 1.6$ per rupee of sales

Loss of contribution during 1977-78 = $1/6 \times 12.00 = 2.00(A)$. . . (2)

Net change of profit due to (1) and (2) = $19.60(F)$

(ii) Material variances

Material cost at 1976-77 price level = $91.10 - \frac{15}{115} \times 91.10 = 79.20$

Material price variance = $79.20 - 91.10 = 11.90(A)$ (3)

Material cost in 1976-77 is 80.00; on this basis, the material cost during 1977-78 should have been = $(108/120) \times 80.00 = 72.00$ (allowable cost).

(This can also be worked out as $80.00 - 10\% \text{ of } 80.00 = 72.00$, taking drop of sales by 10% into consideration).

Material usage variance = $72.00 - 79.20 = 7.20(A)$. . . (4)

(iii) Variable overhead variances

Variable overhead at 1976-77 price level

$$24.00 - \frac{10}{110} \times 24.00 = 21.82$$

Expenditure variance = $21.82 - 24.00 = 2.18(A)$ (5)

Allowance cost = $20.00 - 10\% \text{ of } 20.00 = 18.00$

Efficiency variance = $18.00 - 21.82 = 3.82(A)$ (6)

(iv) Fixed overhead variances

Fixed overhead at 1976-77 price level = $18.50 - \frac{10}{110} \times 18.50 = 16.82$

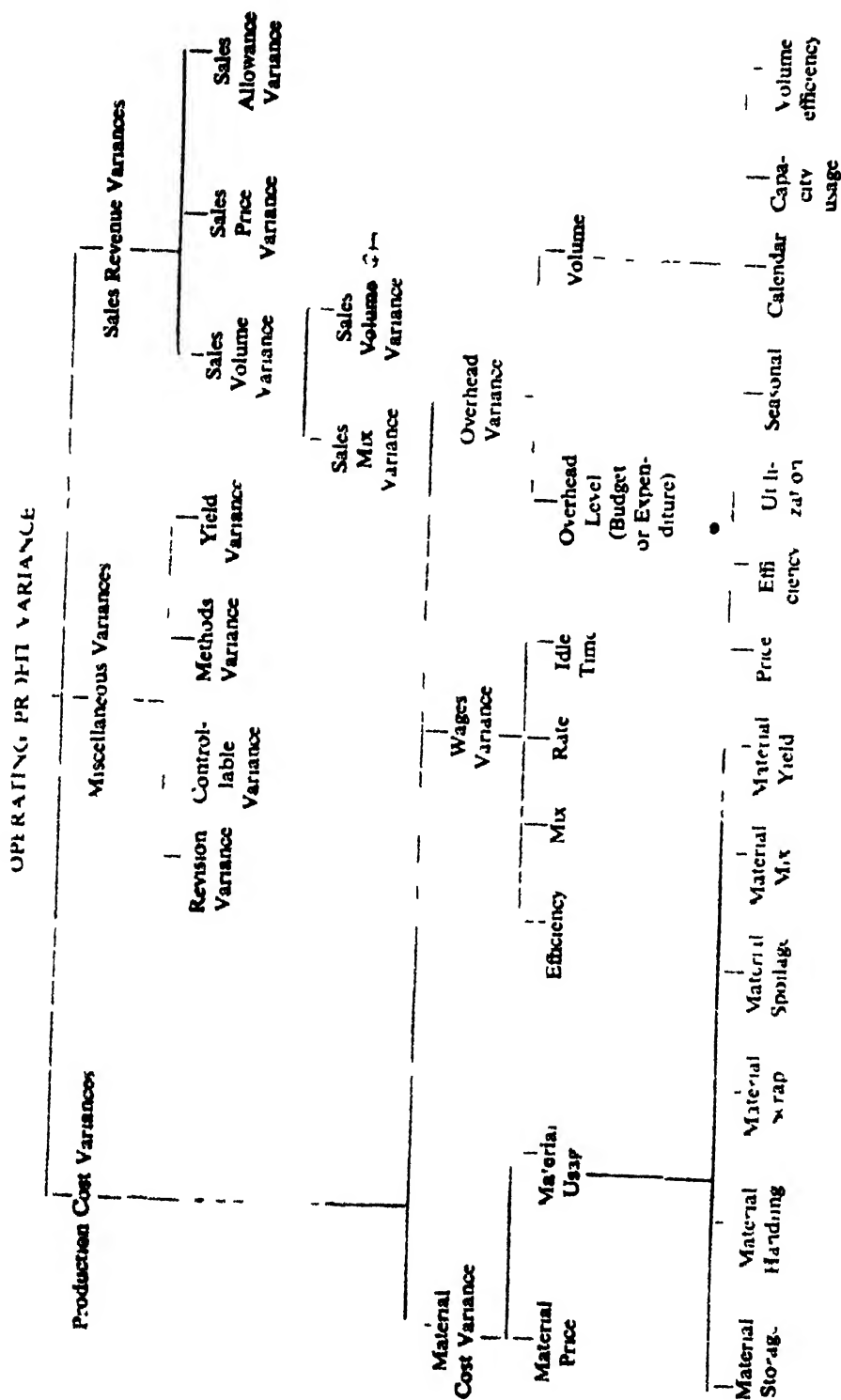


Fig 12.13 Chart showing the relationship between Profit variances and the other variances

Expenditure variance = $16.82 - 18.50 = 1.68$ (A).... (7)

Allowable cost = 15.00

Volume variance = $15.00 - 16.82 = 1.82$ (A)..... (8)

Reconciliation

Profit during 1976-77		Rs. 5,00,000
Add net increase in profit due to sale		(+) Rs. 19,60,000
		<hr/> Rs. 24,60,000
Deduct usage/efficiency variance :		
Material	Rs. 7,20,000	
Variable overhead	Rs. 3,82,000	
Fixed overhead	Rs. 1,82,000	(-) Rs. 12,84,000
	<hr/>	
Deduct price variance		
Material	Rs. 11,90,000	
Variable overhead	Rs. 2,18,000	
Fixed overhead	Rs. 1,68,000	(-) Rs. 15,76,000
		<hr/>
Loss during 1977-78		Rs. 4,00,000

A list of the various types of variances has been given in Fig. 12.13.

EXAMINATION QUESTIONS

- State what you consider to be the limitation of actual product costs, to what extent these limitations are removed by the use of predetermined cost rates, and how far standard costs may further improve the results of product cost ascertainment.
(I.C.M.A., Part IV)
- What are the basic principles that are common to both Standard Costing and Budgetary Control? What are the objectives and uses of Budgetary Control? How far is Budgetary Control possible where production is erratic in nature? (I.C.W.A., Final)
- A manufacturing company is operating a system of cost finding for products. What changes are necessary to establish a comprehensive system of budgetary control and standard costing?
(I.C.M.A., Part IV)
- (a) Who should participate and what part should each play, in setting standards?
(b) For a mechanised process requiring a group of differently graded operatives, tabulate possible reasons for deviations from the labour standard. Show how these deviations are differently treated when setting the standard according to whether (i) perfect, or (ii) attainable performance is the aim. (I.C.M.A., Final)
- It is said that the success of a Standard Cost Accounting system is dependent on the extent of responsibility which the top management assumes in correcting the conditions which cause variances from standards. Discuss the extent to which this responsibility should be delegated to lower levels, and outline the methods by which the performances of individuals responsible can be watched.
(I.C.W.A., Final)
- What information would be required to set a standard manufacturing cost for a completely new machine which an engineering company is to make for sale? From where would this information be obtained?
Present your answer in brief numbered paragraphs. (I.C.M.A., Part IV)
- In a manufacturing activity, materials are issued only at standard rates. What are the implications of this method in Cost Accounting and how can this method be reconciled with that adopted in financial accounting? Illustrate your answer with proforma figures for an integrated system of accounting.
(I.C.W.A., Final)

8. You are preparing standard product costs for a department manufacturing approximately 300 standard products. There are 12 production cost centres in the department, which is served by ancillary services. The organisation as a whole is administered by the usual general administrative departments and executives.

Details the steps which would be necessary to establish the standard overhead costs for each product, and schedule the information which would be required.

(I.C.M.A., Final)

9. What are the probable causes of raw material variances? Illustrate your answer with reference to an industry with which you are familiar. (I.C.W.A., Final)
10. Enumerate the factors which account for variances in the usage of materials and labour. What steps are open to management to maintain budgeted profits when prices of materials and rate of wages increase due to government action?

(I.C.W.A., Final)

11. In any business, an apparent saving in one element of cost may cause a loss in another element of cost, e.g. the use of cheaper materials may result in a lower yield of finished product, or the use of lower grade labour may result in the wasteful use of material.

Explain how a standard costing system deals with this fact (I.C.M.A., Part IV)

12. Where materials are accounted for on the basis of standard cost,
- (a) What adjustments are required for valuing the closing stock on cost or lower market prices?
- (b) What are generally the causes of inefficiency in the use of materials that may be discovered as a result of investigating material quantity variances?

(I.C.W.A., Final)

13. Design a statement to present monthly trading results to the top management of a company which uses standard costs and budgetary control. (I.C.M.A., Inter)

14. XYZ forecasts its overhead expenditure for a period as under.

Rs. 30,000 for 10,000 hours
Rs. 27,500 for 9,000 hours
Rs. 25,000 for 8,000 hours

The normal volume of activity is 10,000 hours. During a period, 8,750 hours were utilised for a total overhead expenditure of Rs. 28,750 of which fixed overheads totalled Rs. 5,250.

The standard utilisation of labour hours should have been less by 5 per cent

How will you analyse the overhead variance? (I.C.W.A., Final)

15. A department in a factory working a 40-hour week can employ upto a maximum of 10 employees.

In a budget period of four weeks it is expected that 4,000 labour hours will be worked, and that production will equal 5,000 standard hours.

At the end of the period it is found that 3,600 labour hours have actually been worked, and production amounts to 4,000 standard hours.

Present figures to management to illustrate efficiency, activity, and capacity usage.

Show where there is scope for improvement, and indicate how the improvement may be effected. (I.C.W.A., Final)

16. A company making brass castings keeps stock records, and has a system of standard costing in operation. The standard mixture is 70 per cent copper and 30 per cent zinc, and it expected that in melting and pouring a 5 per cent loss of metal will occur.

Figures in respect of a costing period are as follows :

	Copper	Zinc
Actual commencing stocks	80 tons	70 tons
Actual purchase	900 tons	350 tons
Actual cost	£210,500	£23,800

Issues (per requisition)	875 tons	385 tons
Actual stocks at end of period	25 tons	30 tons
Standard prices per ton	£230	£70

Actual production of brass during the period was 1,190 tons

Present information to management showing the gains and losses of all types, in respect of materials and material costs only (I C M A, Final)

17. A company manufactures two standard products, the specifications of which are as follows :

	Product A	Product B
Standard cost		
Direct materials	4 lbs. of X @ 12s 6d per lb 6 lbs. of Y @ 13s 4d. per lb	2 lbs. of X 3 lbs. of Y
Direct wages	2 hours @ 5s per hour	1 hour
Overhead	200% of direct wages	200%
Selling per unit	£9	£5

The actual results during the month were

Sales of 32,000 units of product A 15,000 units of product B against a sales budget of £400,000.

Purchase of 240,000 lbs. of X and 135,000 lbs. of Y at an actual cost of £241,150

Materials additional to standard issued were 800 lbs. of X, and 700 lbs. of Y Actual wages paid were £21,480

Production was 36,000 units of product A and 12,000 units of product B, with 83,000 actual man-hours incurred

Actual overhead incurred was £40,000 against a budget of £40,000

You are required to :

- (a) Calculate and show the following variances
 (i) sales value, (i) materials price, (iii) materials usage, (iv) wages rate, (v) labour efficiency, (vi) overhead expenditure, (vii) overhead efficiency
 (b) Draft the month's profit and loss account, utilising the standard cost and showing the variances as calculated (I C M A, Inter)

18. Define (a) Yield variance, (b) Sales volume variance

Illustrate your answer with an example of each calculated from the following figures :

Budgeted sales	1,020 units
Standard yield per batch	106 gallons
Actual sales	1,130 units
Actual yield	1,000 gallons
Standard cost per gallon	6s 8d per gallon
Standard selling price per unit	£5 per unit
Actual number of batches	30 batches

(I C M A, Inter)

19. A plastic floor covering is produced in rolls, 72 inches wide and 60 feet long. The materials used are mixed in batches and fed into a continuous processing machine.

The standard mixture used in a batch, which should produce 600 square yards of floor covering, is as follows :

1,000 lbs. material	A	at	2s per lb
600 lbs. material	B	at	3s per lb
100 gallons material	C	at	16s. per gallon

During a period in which 1,830 standard sized rolls are produced, 120 batches of materials were made up, and the actual usage of materials was found to be as follows :—

114,000 lbs. material	A	at	2s. 2d per lb
75,000 lbs. material	B	at	3s. 2d. per lb
12,500 lbs. material	C	at	17s. per gallon

Present figures to management to explain the variances arising during the period (I.C.M.A., Inter)

20. Distinguish between :

- (a) an efficiency ratio and
 (b) an overhead efficiency variance

Illustrate your answer with an example of each calculated from the following figures :

Actual hours worked	12,000	
Flexible budget-overhead allowances	£5,750	
Standard man-hours per unit	200	
Standard overhead rate per standard man-hour	10s.	
Actual units produced	50	(I.C.M.A., Inter)

21. The following standard cost details apply to a manufacture's product which sells at £10. 10s. per unit :

Purchase :		£	s.	d.
Raw material	15 lbs. at 2s. per lb	1	10	0
Fixing and fastening items :				
bought out finished	6 at 3d. each		1	6
Wages : direct	6 hours at 10s. per hour	3	0	0
Overhead	6 hours at 15s. per hour	4	10	0
		£9	1	6

Production accounts are debited at actual cost. Completed work is credited at standard cost.

The details which follow relate to the period under review :

Opening stock : finished product	..	2,000 units
work in-progress	..	Nil
Budgeted overhead	..	£13,500
Budgeted hours of direct labour	..	18,000
Budgeted output of finished product	..	3,000 units
Actual output of finished product	..	3,400 units
Sales of finished product	..	4,500 units

Raw material usage : 54,000 lbs. at 2s. per lb

Fixing and fastening items : bought out finished : 20,000 at 3d. each.

Direct wages : 20,550 hours at 10s. 3d. per hour.

Actual overhead : £13,980.

You are required to :

- journalise the transactions detailed above, and the net overall variance ;
- determine the variances from the standard for :
 - raw materials,
 - bought out finished items,
 - wages, and
 - overheads.
- So far as can be derived from the information given, analyse by causes the variances referred to in (b) above. (I.C.M.A., Part IV)

22. A brass foundry, making castings which are transferred to the machine shop of the same company at standard prices, uses a standard costing system. Basic standards in regard to materials, stocks of which are kept at standard prices are as follows :

Standard mixture	70% Copper
	30% Zinc
Standard prices	Copper £240 per ton
	Zinc £65 per ton
Standard loss in melt	5% of input
Figures in respect of a costing period are as follows :	
Commencing stocks :	Copper 100 tons
	Zinc 60 tons
Finishing stock	Copper 110 tons
	Zinc 50 tons

Purchase : Copper	300 tons, cost £73,250
Zinc	100 tons, cost £6,250
Metal melted	400 tons
Casting produced	375 tons

Present figures showing : (a) material price variance ;
 (b) material mixture variance ;
 (c) material yield variance.

(I.C.M.A., Part IV)

23. A small company making a single standard product, produces accounts for a costing period as follows :

	£
Direct material	396
Direct wages	596
Variable overheads	970
Fixed overheads	520
Profit	488
Sales	2,970

The original budget was in respect of 1,000 units per period, but during this period only 960 units were produced and sold.

Standard direct wages rate is 6s. per hour and standard variable overhead rate is 10s per hour.

Cost variances during the period are as follows :	Gain	Losses
	£	£
Material price	—	4
Material usage	—	8
Wages rate	10	—
Labour efficiency	—	30
Variable overhead price	40	—
Variable overhead efficiency	—	50
Fixed overhead cost	—	20
Sales price	30	—

From this information prepare for the period the original budget and budgeted cost of actual sales and prepare a statement showing all standards in respect of the product.

(I.C.M.A., Part IV)

24. A gang of workers normally consists of 10 men, 5 women and 5 boys, paid at standard hourly rates of 8s, 6s, and 4s. respectively. In a normal working week of 40 hours the gang is expected to produce 1,000 units of output.

In a certain week, the gang consisted of 13 men, 4 women and 3 boys ; 72 hours were worked ; actual wages paid amounted to £250 ; 1,000 units of output were produced.

Present information in respect of labour cost variance arising during this period.

(I.C.M.A., Part IV)

25. A foundry producing casting of a standard alloy uses standard costs. The standard mixture is as follows :

40% material A at £300 per ton
 30% material B at £100 per ton
 10% material C at £420 per ton
 20% scrap metal of this alloy.

It is expected that from each charge there will be a 5% loss in melt, 35% will be returned to scrap stock (runners, heads, etc.) and 60% will be good castings. Scrap is credited and charged at the standard average cost of the metal mixture.

In a certain period the following materials are purchased and used :

380 tons material A at £310 per ton
 330 tons material B at £110 per ton
 90 tons material C at £420 per ton
 200 tons scrap metal at standard price,

From this material, 608 tons of good castings are produced and 340 tons of scrap metal are returned to scrap metal stock.

Present information to management showing standard metal costs, and variances from standard in respect of this period. (I.C.M.A., Pt. IV)

26. Calculate the variances in the following cases and add your comments :

	Standard	Actual
Materials :	400 lbs. at Rs. 2 per lb. ;	420 lbs. at Rs. 2.10 per lb.
Wages :		
Trained labour	80 hrs. at Rs. 1.50 per hr. ;	70 hrs. at Rs. 1.50 per hr.
Untrained labour	600 hrs. at Re. 0.90 per hr.,	620 hrs. at Re. 0.90 per hr.
Overhead :	700 hrs. at Re. 0.95 per hr. ;	720 hrs. at Re. 0.90 per hr.
		(M.Com., C.U.)

27. A factory works on the standard costing system.

The standard estimates for materials for manufacture of 1,000 units of a commodity is 400 kg at Rs. 2.50 per kg.

When 2,000 units of the commodity are manufactured, it is found that 820 kg. of materials are consumed at Rs. 2.60 per kg. Calculate the material variances.

(M.Com., C.U.)

28. An Engineering works has a standard costing system for its single output. Their standard was as follows :—

Standard direct labour cost per unit—20 hours at Rs. 1.50 per hour.

Standard material cost per unit—20 lbs. at Rs. 2 per lb.

Standard overhead rate at Rs. 3 per standard labour hour.

The following operating data were taken for November, 1967 :—

In process at 1st November, 1967—Nil.

Completed during the month—1,000 units.

In process at 30th November, 1967—100 units on which 50% work is completed and for which all materials were issued.

Direct labour cost was Rs. 32,000 at Rs. 1.60 per hr. ; 21,000 lbs. of materials were issued at Rs. 1.90 per lb.

Actual overhead—Rs. 64,000.

You are required to prepare a statement comparing Actual and Standard costs of production for November, 1967 analysing variances on materials, labour and overhead costs.

Note : Work-in-process at 30th November, 1967 may be valued at standard cost. (I.C.W.A., Inter)

29. A system of Standard Costs is adopted by S & Co. Ltd. for the four weeks ended 31st March, 1970. The following was their Trading and Profit and Loss Account :

	Rs.		Rs.
Materials consumed	5,14,800	Transfer to Sales Dept.	
Direct Wages	1,41,750	(9,000 units of finished	
Fixed Overhead	94,000	articles @ Rs. 100 each)	9,00,000
Variable Overhead	31,000		
Profit	1,18,450		
	<hr/>		<hr/>
	9,00,000		9,00,000

You are also furnished the following information :—

- (a) The articles manufactured are identical and on completion are transferred to Sales Department. There was no opening or closing work-in-progress.

- (b) The Standard production capacity is 10,000 units for a four week period, and the Standard selling price is as below :

	Per Unit Rs.
Direct Material, 25 kgs. at Rs. 2 per kg.	50
Direct Wages, 5 hours at Rs. 3 per hour	15
Fixed Overhead	10
Variable Overhead	5
Standard Cost of Sales	80
Standard Profit	20
Standard Sale Price	100

- (c) Actual figures per unit of product were :
 Direct Material, 26 kgs. at Rs. 2.20 per kg.
 Direct Wages, 4½ hours at Rs. 3.50 per hour

You are required to draft a Trading and Profit and Loss Account on Standard Cost lines, showing the variances contributing to the actual profit obtained.

(M.Com., C.U.)

30. A chemicals company manufactures two sorts of crop spray.

You are required from the information given to :

- (a) Calculate the difference in total sales margin between the budget and the actual results ;
 (b) Analyse this difference into variances due to :
 (i) selling price ;
 (ii) cost of sales ; and
 (iii) sales quantity (mixture).

Data :

	Budget		Actual	
	Type A	Type B	Type A	Type B
Sales, in gallons	20,000	15,000	15,000	18,000
Per gallon :	£	£	£	£
Selling price	5.80	8.40	6.20	7.70
Cost of sales	2.60	4.30	2.30	3.90

(I.C.M.A., Final)

31. A company manufactures a product by passing raw materials through a series of processes.

Materials used consist of three basic materials as follows :

Material		Standard price per ton £
A	50%	30
B	30%	50
C	20%	70

There is an expected (standard) loss of 12% in processing.

Standard costs are in operation, and during one month 90 batches of 10 tons are put into process.

Commencing stocks are :

Material	Tons
A	70
B	20
C	80

Purchases during the period are :

Material	Tons	Cost £
A	400	12,500
B	250	10,400
C	200	14,750

Requisitions show that 900 tons have been issued, but divided as follows :

Material	Tons
A	460
B	260
C	180

Actual production amounts to 788 tons of finished product.

Stock-taking reveals the following stocks at the end of the period :

Material	Tons
A	5
B	15
C	85

Present figures to management, showing actual costs, standard costs and all variances, assuming that there is no work-in-progress at the beginning and end of the period.
(I.C.M.A., Final)

32. A company manufactures two products Stanco and Actco. It budgeted to produce five batches of Stanco and six batches of Actco each month. The standard material details for each product are as follows :

Stanco			Actco		
Material	Percentage used	Standard price per ton	Material	Percentage used	Standard price per ton
S 1	70	£ 6	A 1	40	£ 15.00
S 2	30	£ 10	A 2	60	£ 18.50

Loss is 10% of input

Loss is 5% of input

Actual details of production for May were :

Consumption :

Stanco			Actco		
Material	Tons used	Actual price per ton	Material	Tons used	Actual price per ton
S 1	300	£ 7	A 1	300	£ 14
S 2	200	£ 9	A 2	300	£ 19

Output :

455 tons from 5 batches

568 tons from 6 batches

There were no opening or closing stocks of finished products.

The cost accountant has commenced the compilation of the Profit and Loss Statement for May as given below :

Profit and Loss statement for the month of May.

	Stanco £	Actco £	Total £
Budgeted sales	15,750	34,200	49,950
Sales variances	320(F)	552(A)	232(A)
	<hr/>	<hr/>	<hr/>
Less Standard cost of sales :			
Direct materials			
Direct labour	2,275	5,680	7,955
Overheads	7,735	12,496	20,231
	<hr/>	<hr/>	<hr/>

Standard Profit		_____	_____	_____
Production variances :		_____	_____	_____
Materials : Price				
Mix				
Yield				
		_____	_____	_____
Labour :	Rate	40(A)	55(A)	95(A)
	Efficiency	60(F)	45(F)	105(F)
		_____	_____	_____
Overhead :	Expenditure	45(A)	40(A)	84(A)
	Efficiency	200(F)	100(F)	300(F)
	Capacity	9(A)	140(A)	230(A)
		_____	_____	_____
Total		_____	_____	_____
Actual profit		_____	_____	_____
		_____	_____	_____

Note : Adverse variances are indicated by "A" and favourable variances by "F".

(a) Compile the standard product costs for a standard batch of 90 tons output of Stanco and a standard batch of 95 tons output of Actco.

(b) Complete the Profit and Loss Statement for May. (I.C.M.A., Inter)

33. A company operating a standard cost system uses standard direct wages rates of :

	Per hour
	£
Department : A	0.73½
B	0.70
C	0.75

During the month of November there was produced .

	Standard hours allowed
Department : A	180 dozen at 270 per gross
B	30 gross at 26 per dozen
C	9,600 units at 130 per 100 units

There was worked :

	Actual hours		Actual hourly wage rate
			£
Department : A	4,080	at	0.75
B	9,900	at	0.66½
C	11,000	at	0.80

You are required to calculate and present to works management in summary form for each department and in total the standard value of production and the appropriate variances which arise. (I.C.M.A., Inter)

34. A company producing a single product anticipated certain amount of profit on an expected production and sale of 80,000 units, but found on actual working that the profits turned out to be much below expectation. From the following particulars, you are required to draw up a reconciliation between the company's actual and

budgeted profits explaining the variations due to the various causes. You are also required to determine in particular, the material price variance, wage rate variance and sale price and volume variance :

	Anticipated	Actual
Units	80,000	70,000
Net selling price per unit	Rs. 40	Rs. 72
Material per unit	Kgs. 4	4
Rate of material per Kg.	Rs. 4	Rs 4.50
Labour hours per unit	5	4.50
Rate per labour hour	Re. 1	Rs. 1.20
Variable overheads per labour hour	Rs. 1.60	2.00
Fixed overhead per unit	Rs. 2.00	Rs. 2.40

(I.C.W.A., Inter)

35. PH Ltd. has furnished you the following budget for its mechanic shop for an average month :—

No. of direct workers	40
Working days per month	25
Normal hours per day	8
Downtime budget	10%
Budgeted efficiency	one standard hour per actual hour worked
Budgeted overheads p.m.	
Fixed	Rs. 28,800
Variable with operator hours	Rs. 39,600
Variable with output	Rs. 14,400

The actual data for the month of November, 1982 are as under :—

Net operator hours worked	5,000
Standard hours produced	5,200
Overheads incurred :	
Fixed	Rs. 31,000
Variable with operators hours	Rs. 28,000
Variable with output	Rs. 10,000

Prepare a report to the departmental manager setting out the analysis of variances.

(I.C.W.A., Final)

CHAPTER 13

UNIFORM COSTING AND INTER-FIRM COMPARISON

Uniform Costing. Uniform costing refers to the use by several undertakings of the same costing principles or practices. It is not a distinct or separate method of cost accounting but is only a particular technique that applies the usual accounting methods like process or job costing, standard costs, budgetary control, and marginal costing. The main feature of uniform costing is that whatever be the method of costing used, it is applied uniformly in a number of concerns in the same industry, or even in different but similar industries. This enables cost and accounting data of the member undertakings to be compiled on a comparable basis so that useful and crucial decisions can be taken. The principles and methods adopted for the accumulation, analysis, apportionment, and allocation of costs vary so widely from concern to concern that comparison of costs is rendered difficult and unrealistic. Uniform costing attempts to establish uniform methods so that comparison of performances in the various undertakings can be made to the common advantage of all the constituent units.

Scope of Uniform Costing. Uniform costing methods may be applied in (i) a single enterprise having a number of branches or units, each of which may be a separate manufacturing unit, (ii) a number of concerns in the same industry bound together through a trade association or otherwise, and (iii) industries which are similar in nature such as gas and electricity, various types of transport, and cotton, jute, and woollen textiles. In the first type of organisations, the parent or head office usually controls the operation of the uniform costing system. Where the products manufactured by the branches are identical, installation of uniform methods does not present any difficulty. Even in cases where the nature of the products manufactured by the various branch units vary, there might be several common processes or operations, or comparable machines and services which may be standardised and uniform costing made applicable to them. In short, the need for application of uniform costing system exists in a business, irrespective of the circumstances and conditions prevailing therein. In concerns which are members of a trade association, the procedure for uniform costing may be devised and controlled by the association or by any other central body specially formed for the purpose.

Requisites for Installation of a Uniform Costing System. The organisational set up for implementing the principles and methods of uniform costing may take different forms. It may range from a small association of a number of concerns who agree to have uniform information regarding a few specific cost accounting aspects, to a large organisation which has a fully developed scheme covering all the aspects of costing. The success of a uniform costing system will depend upon the following :-

- (i) There should be a spirit of mutual trust, co-operation, and a policy of give and take amongst the participating members.

- (ii) There should be a free exchange of ideas and methods.
- (iii) The bigger units should be prepared to share with the smaller ones, improvements, achievements of efficiency, benefits of research, and know-how.
- (iv) There should not be any hiding or withholding of information.
- (v) There should be no rivalry or sense of jealousy amongst the members.

The cost structures obtaining in the various member units which decide to have a uniform system vary widely and even in cases where the units manufacture identical products or are engaged in common processes, the individual costs may be different. In the application of uniform costing, the fundamental requirement is, therefore, to locate such differences and to eliminate or overcome, as far as practicable, the causes giving rise to such differences. The likely basic reasons for the differences may be as follows :-

- (i) *Size and organisational set up of the business*: In a small firm, several functions are combined and performed by a single individual, whereas in big concerns there is usually, a division of labour ; a work may be broken up into a number of elements or components, each of which is performed by a number of individuals. The number and size of the departments, sections, and services also vary from one concern to another according to their size and organisation. Then again, the spending level in larger undertakings is higher ; such concerns are more liberal in matters like employment of staff, and fixation of their pay scales, and provision of amenities.

The difficulty in operating uniform cost systems for companies that vary widely in regard to size and type of business may to some extent be overcome by arranging the various units in a number of size or type ranges, and applying different uniform systems for each such type.

- (ii) *Methods of production* : The use of different types of machines, plant and equipments (for example, one concern may have at its disposal automatic machines, another may use ordinary machines, while a third one may employ only manual methods), degree of mechanisation, difference in materials mix, and sequence and nature of operations and processes are mainly responsible for the difference in costs.
- (iii) *Methods and principles of cost accounting applied* : It is in this sphere that the largest degree of difference arises. Undertakings manufacturing identical or similar products and having the same system of cost accounting would generally employ different methods of treatment of expenditure on buying, storage, and issue of materials, pricing of stores issues, payment to workers, basis of classification and absorption of overhead, calculation of depreciation, charging rent on freehold or leasehold assets, etc.

Fields Covered by Uniform Cost System. There is no system of uniform costing that may be found to fit in all circumstances. The system to be installed should be tailored to meet the needs of each individual case. The extent to which uniformity should be achieved in regard to the various aspects of cost accounting

depends mainly on the purpose for which uniform costing is required. For example, if it is desired to install uniform costing in order to have a means of fixation of common prices for the products, uniformity to the extent it is necessary to find the costs of products will suffice, and member units may not be interested in achieving uniformity in other respects, say, in the costs of cost centres. The latter will, however, be necessary if comparison of the performances of cost centres is desired.

The essential points on which uniformity is normally required may be summarised as follows :—

- (i) Whether costs are required for the individual products, i.e. for the cost units or for cost centres.
- (ii) The method of costing to be applied, i.e. whether job costing or process costing, or a variation of either of the two is to be employed.
- (iii) The technique employed, viz. standard costing, marginal costing, historical costing, etc. and the method of treatment in cost accounts of the variances from standard costs.
- (iv) Definitions of the various elements of costs, i.e. direct materials, direct labour, direct expenses, manufacturing, administration, selling, and distribution costs. This would cover the definitions of direct and indirect material and direct and indirect labour.
- (v) Items to be excluded from costs.
- (vi) The basis of departmentalisation.
- (vii) The basis of allocation of costs to departments and of service department costs to production departments.
- (viii) The basis of apportionment of production department costs to cost units, i.e. the basis for recovery of overhead and the method of treatment of under- and over-absorbed overhead expenses.
- (ix) The methods of application of administration, selling and distribution overhead to cost of sales.
- (x) The method of valuation of work-in-progress.
- (xi) The methods of valuation of capital assets and computation of depreciation and rates of depreciation.
- (xii) Method of treatment in costs of interest on capital and notional rent of owned building and premises.
- (xiii) Methods of treating cost of spoilage, defective work, scrap, and wastage.
- (xiv) Treatment of research and development costs.
- (xv) Methods of remunerating the workers.
- (xvi) Methods of accounting of overtime pay, bonus and other miscellaneous allowances paid to workers.
- (xvii) Whether purchase, material handling and upkeep expenses are added to the cost of stores or are treated as overhead expenses.
- (xviii) The system of materials control—pricing of issues and valuation of stock.
- (xix) The system of classification and coding of accounts.
- (xx) The method of recording accounting information (e.g. integrated accounting system).

Uniform Cost Manual. For the efficient management of uniform cost programme, a cost manual that lays down the recommended cost accounting plan and the procedure for operating it, is developed and circulated to the participating concerns by a central body, viz. the coordinating organisation. The cost manual serves as a formal evidence of the uniform system agreed upon and is of immense help in guiding the participating firms to arrange their systems of accounting so that the uniform principles are correctly applied. The manual describes, among other things, the scheme and the method of its administration and the procedure to be followed for regular collection, analysis, and reporting of cost data, and their interpretations to the member units. The size, form, and contents of a cost manual vary depending mainly upon the type and extent of the uniform plan and the method of presentation of the figures. A schedule of main and sub-headings for a typical uniform cost manual is illustrated below :

A. Introduction

Statement of objectives and purpose of the system.
 Scope of the system.
 Advantages to be derived.
 Educating the management to appreciate the system.
 Ideas on selling the system to the management and the extent of co-operation expected from the member units.

B. Organisation

Organisation for developing and operating the system, i.e. whether the system is to be installed and operated by a team of cost accountants drawn from the various units within the industry or by outside cost consultants.
 Stages in which the system is to be introduced.

C. Accounting system

General principles of accounting adopted.
 Nature of coding system.
 Terminology to be used.
 Classification and description of accounts. (A complete chart giving detailed explanations of the nature of transactions booked to each.)

D. Cost accounting system

Method of costing used (i.e. job, process, standard cost etc.)
 Relation between cost and financial accounts.
 System of integration of accounts.
 Financial period to be taken.
 Items to be excluded from or included in costs.
 Classification of departments (e.g. producing and service departments).
 Material cost—treatment of handling and storage costs, scrap, defective work, waste, and losses, pricing of material issues, classification of direct and indirect materials, etc.
 Labour cost—direct and indirect wages classification, treatment of idle time, overtime and shift allowances ; treatment of labour related costs, as for example, dearness allowance and leave pay.

Overhead—classification, collection, apportionment, and allocation of overhead to production, finished goods, and cost of sales ; method of allocation and apportionment of service department expenses to producing departments ; calculation of depreciation, method of revaluation and accounting of depreciation on machines that outlive their lives, i.e. machines which are at nil book value but are still serviceable ; administration and selling and distribution overheads.

E. *Presentation of information*

Forms and contents of statements to be prepared and dates of submission.
 Reports to shareholders.
 Reports to management.
 Operation and production costs.
 Cost ratios.
 Other financial ratios.
 Supplementary information.

F. *Miscellaneous*

Advantages and Limitations of Uniform Costing. *The advantages of uniform costing system are manifold. These are summarised below :*

- (i) Uniform costing is a useful tool for management control. Performances of individual units can be measured against norms set for the industry as a whole. In fact, uniform costing assists in the standardisation of operations and performances in the industry.
- (ii) It avoids cut-throat competition by ensuring that competition among member units proceeds on healthy lines.
- (iii) Weaker member units can take advantage of the efficient methods of production and production control of the better managed units so as to increase their own efficiency. This provides stability in the industry.
- (iv) Research and development on a large scale is possible only in big companies. The fruits of research and development carried out by bigger organisations may be shared by the smaller units. There is a pooling of resources leading to economy in the industry as a whole.
- (v) By showing the one best way of doing things, uniform costing creates cost consciousness and provides the best system of cost control and cost presentation in the entire industry.
- (vi) It enables furnishing of suitable statistics to the Government whenever called upon to do so. This is particularly useful when the Government desires to obtain data for ensuring effective price control. Similar considerations apply if it is proposed to give protection or subsidy to a particular industry, to fix import license quota for scarce materials, or to deal with such other connected matters.
- (vii) Uniform costing simplifies the work of wage boards set up to fix minimum wages and fair wages for an industry.
- (viii) Prices based on uniform information may be taken to be reliable and representative of the whole industry. This creates customer confidence and improves relations between the customer and the business.

- (ix) Uniform costing assists in educating the less informed units in regard to cost accounting methods. Individual units need not indulge in expensive experimentation to achieve efficiency.
- (x) In the mixed economy in India where public undertakings operate side by side with the private sector undertakings, uniform costing enables a comparative assessment to be made of the two sectors.
- (xi) In the case of amalgamated companies or in companies that have several factories or units under their control, introduction of uniform cost system provides a ready means of comparing production efficiency and production costs. This would enable the concerns to effect costs reduction and also to plan properly the production programmes of the individual factories.

Uniform cost system has, however, certain *limitations and disadvantages*. These are :

- (i) Practices as necessitated by conditions and circumstances vary in the industry from one unit to another. The factors leading to the differences among the member units such as location, age and conditions of the plants, nature of the labour force, capital investment, and degree of mechanisation are sometimes so wide that it becomes difficult to have an efficient uniform system that would be suitable for big and small concerns alike.
- (ii) For smaller units, the cost of installation and operation of a uniform system may not be commensurate with the advantages derived.
- (iii) If complete agreement between the members is not forthcoming or if due to mistaken notions on their part, some reservations are made, or if some information is withheld on grounds of secrecy or privacy, the statistics presented cannot be relied upon. This weakens the uniform system and reduces its usefulness.
- (iv) Uniform costing may create conditions that are likely to develop monopolistic tendencies within the industry. Prices may be raised artificially and supplies curtailed.

Inter-Firm Comparison. Inter-firm comparison is the technique by which the performances, efficiencies, costs, and profits of various concerns in an industry are studied on a voluntary basis by exchange of information and a relative comparison is made. Inter-firm comparison naturally follows a uniform cost system ; in fact, uniform costing is the foundation stone over which interfirm comparison is developed and applied in a wider field. Inter-firm comparison is usually made in codes with the help of ratios without disclosing or passing on the absolute data obtained from one business to another. For this purpose, data are collected from the participating companies by a central coordinating organisation and are analysed and presented in a suitable form to all the member units so that each firm may compare its own performances and results with those of the rest. This enables the weaker units to probe into the reasons leading to any short-comings so that remedial measures may be taken to overcome or eliminate

them. Thus, inter-firm comparison is a tool for control—control by comparing own performances with those of other competitors in the field, for increasing efficiency and thereby maximising profits.

Comparability of Firms. In order to obtain the best results from a system of inter-firm comparison, it should be seen that the participating organisations are sufficiently comparable. One important point which should be kept in view is that comparison should always be made on a like to like basis. Enterprises engaged in the same industry provide ideal comparable data though differences in size, methods of production and distribution, use of plant and equipments, and operation in different areas present some difficulty. In such cases, a reasonable extent of comparability may be achieved by classifying the concerns into a number of groups on the basis of size, amount of capital employed, and location of the firms.

Inter-firm comparison can also be profitably made in respect of concerns engaged in different industries though the scope and area of comparison in such circumstances are evidently narrowed down. Individual costs may not be comparable but certain ratios such as profit to capital employed, operating profit to operating assets or different types of expenditure to total sales may be found useful for locating spots where it may be possible to achieve economies.

Necessity for Inter-Firm Comparison. Inter-firm comparison solves many problems of a concern by indicating the efficiency of production and selling, adequacy of profits, weak spots in the organisation, etc. A question may, however, be asked as to why is it necessary to have a system of inter-firm comparison for control when the cost accountant has at his command, so many other methods of control like standard costing, budgetary control, etc. The answer is that firms that operate a system of standard costing, and so consider that little will be gained by participating in a scheme of inter-firm comparison are living in a closed house. A standard set within a firm is based on own knowledge, skill, and experience, with reference to the conditions prevailing inside the firm. Such a standard may perhaps be suitable for the purpose of internal control, but its validity cannot be accepted unless it is compared with a yardstick; the norm set in other comparable firms provides such a yardstick. Inter-firm comparison enables the management to challenge the standard which it has set for itself and to improve upon it in the light of the information gathered from more efficient member units.

Requirements of an Inter-Firm Comparison Scheme. In the installation of a scheme of inter-firm comparison, the following essential points are to be considered :—

1. *The nature and extent of information to be collected from the participating firms.* The earlier use of inter-firm comparison was limited to credit rating or credit control and investment analysis, for which purpose, the published accounts of the companies were taken and annual ratios surveys were conducted by certain organisations. The scope of inter-firm comparison has since grown rapidly and there is practically no limit to the information that can be exchanged under an inter-firm comparison scheme. The nature and extent of information collected

from the participating firms depend upon the needs of the management, comparative importance of the information, and the efficiency of the central organisation responsible for collection of data. The main point to be kept in view is that only the barest possible information should be collected. Obtaining a mass of data may be confusing ; some of the information collected may not be utilised fully or gainfully and the cost of collection may be prohibitive.

Another consideration is that the scheme of collection of data should be comprehensive. There are numerous factors in a concern which interplay and unless the scheme covers all such related factors, the results may be misleading. For example, a low percentage of wastage in manufacture may be accompanied with high machine costs. Any inter-firm comparison of either wastage or machine costs in isolation without showing the relationship between the two would, therefore, be meaningless.

No standard list of comparable data that would suit all industries can be given. The general lines on which information may be collected are given below :

- (a) Information regarding costs and cost structure as obtained in the case of uniform costing.
- (b) Labour efficiency and labour utilisation.
- (c) Machine efficiency and machine utilisation
- (d) Raw material consumption.
- (e) Wastage.
- (f) Inventory.
- (g) Return on capital employed.
- (h) Liquidity.
- (i) Reserves and appropriations of profit.
- (j) Creditors and debtors.
- (k) Methods of production and technical aspects.

2. *The organisation responsible for the collection, coordination, and presentation of information.* Inter-firm comparison has made a rapid headway in the developed countries and special organisations have been set up to look after the task. In the U.K. for example, there is an organisation known as the 'Centre for Inter-firm Comparisons' which undertakes this work by direct arrangement with individual firms or by rendering consultant services to the trade associations. It also carries out research, organises seminars, conferences, etc. on inter-firm comparison, and provides a fund of information for the benefit of the various industries. There are other similar organisations like the British Federation of Master Printers and the British Steel Founders' Association which undertake inter-firm comparison work for the members in particular industries.

Though in this country there is no organisation like the Centre for Interfirm. Comparison, efforts on the lines are being made by several trade and manufacturing associations, chambers of commerce, the National Productivity Council, and the research and statistical wings of several commerce and trade journals and periodicals. The latter compile and publish periodically useful statistics as available from the annual accounts and reports of individual companies.

Comparable information is obtained from these journals on the basis of which the management of a concern may carry out a 'self analysis' of the business by comparing its own performances with those of others in the line.

3. *Method of collection and presentation of information.* Information is supplied by the participating firms to the central organisation at regular intervals. The required information is generally standardised and is given on a suitably designed standard form circulated earlier to all the firms. Sometimes, a questionnaire is issued by the central organisation and the firms are asked to send replies to the questions. Information may also be collected on the spot by fieldworkers but this is an expensive procedure. As the compilation of information involves time and expenditure on the part of the participating firms and the co-ordinating centre, the frequency at which each information is to be supplied should be fixed according to its utility and the cost thereof. Information is usually collected once a year because many of the figures are obtained from the annual trading and profit and loss accounts and balance sheets of the companies.

On receipt in the central organisation, the information is properly sorted out, and relevant data in the form of a consolidated report are issued to the individual firms. The information, which is kept absolutely secret, is supplied only to the members and no unauthorised person is given any access to it. Usually, ratios and not absolute figures are supplied by the firms. Absolute figures even if supplied are not passed on to other members. As a further safeguard, each type of ratio is allotted a code number, each firm is known by a number, and its identity is not revealed in the reports made and sent out by the central organisation. The key to the firms' code numbers is not supplied to individual firms so that each firm knows its own number but is unaware of the identity of other firms whose figures it receives for comparison purposes.

The presentation of figures to participating members should be so designed as to show variances from the norms. The variances may be of two types, namely, those which are anticipated due to basic differences in the nature of the particular firms, and those which arise due to efficiency or inefficiency in performances. The latter type of variances needs to be investigated and explained.

Scheme of Management Ratios for Inter-Firm Comparison. As stated previously, one of the important points in inter-firm comparison is to ensure that similar or like to like data are taken so that the comparison is not vitiated due to factors which differ from unit to unit. Comparison of absolute figures without taking their relationship into account with one another is meaningless. For example, any comparison of the number of workers, capital invested, direct wages, or material costs in widely differing units conveys no idea. The best method of inter-firm comparison is, therefore, to establish suitable relationships between the various factors in a firm and compare each such relationship with those obtaining in the other member units. The ratios would, therefore, indicate the relative efficiency of the firm and would assist in planning. A guide to the business trend may also be provided if management ratios are compared from period to period. Most of the items appearing in the Trading and Profit and Loss Account of a concern may be shown against suitable bases such as machine hours, labour hour, number of direct workers, quantity of sales, or percentage

of sales. Similarly, ratios like profit per unit of product, profit per unit of sales, profit per rupee of capital invested, and output per worker, all of which provide useful indices for measurement of performance and efficiency, may be utilized for the purpose of inter-firm comparison.

A scheme of management ratios operated for inter-firm comparison is described here. The scheme is based on the practice followed by the British Federation of Master Printers which adopts the so-called 'pyramid structure' of ratios. The most important ratio is the return on capital employed (i.e., *Net profit/Capital employed*) which gives a measurement of the overall performance of a concern. This ratio, which forms the top or apex of the pyramid structure,

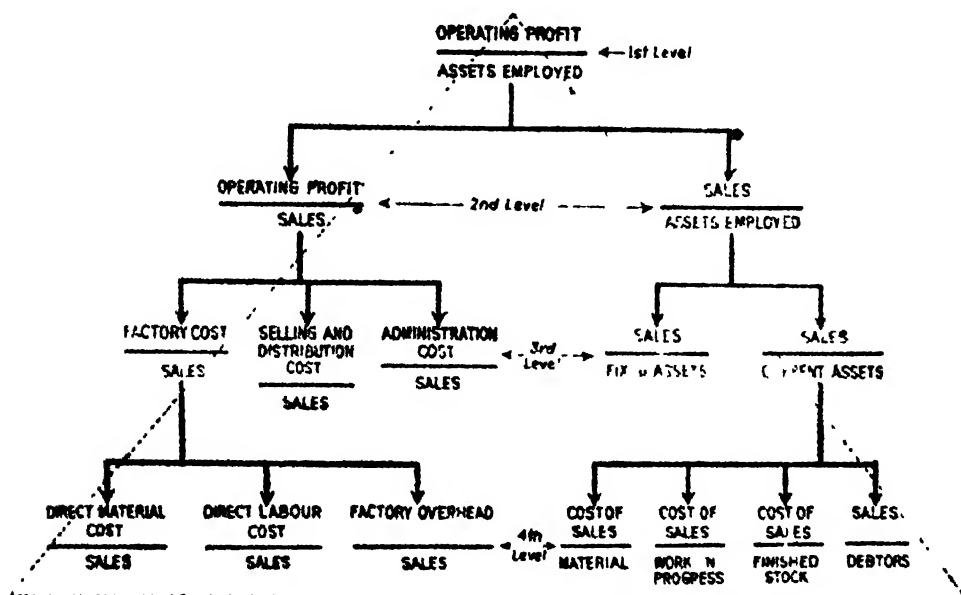


Fig. 13.1 Pyramid Structure of Ratios

Note . 1st level shows the primary ratio.

2nd level indicates explanatory ratios accounting for the make-up of the primary ratio.

3rd level consists of general explanatory ratios accounting for differences in the explanatory ratios.

4th level contains specific explanatory ratios accounting for differences in general explanatory ratios.

is further analysed into the following two constituent ratios which form the second level of the pyramid (see Fig. 13.1) :

$$\frac{\text{Profit}}{\text{Sales}} \text{ and } \frac{\text{Sales}}{\text{Capital employed}}$$

Each of the above two ratios is further broken down to the third level and to the fourth and subsequent levels, if necessary, as illustrated in the 'pyramid'.

Besides the above mentioned ratios, a large number of other ratios may be computed for the purpose on inter-firm comparison. Some of these are listed below by way of illustration :

1. $\frac{\text{Current assets}}{\text{Current liabilities}}$	(Current ratio)	14. $\frac{\text{Cost of raw materials}}{\text{Man hours or Machine hours}}$
2. $\frac{\text{Liquid assets}}{\text{Current liabilities}}$	(Liquid ratio)	15. $\frac{\text{Cost of raw materials}}{\text{Quantity produced}}$
3. $\frac{\text{Sundry debtors}}{\text{Sales}}$		16. $\frac{\text{Cost of scrap}}{\text{Cost of raw materials}}$
4. Average collection period		17. Wages per employee
		18. Plant value per employee
5. $\frac{\text{Cost of sales}}{\text{Average inventory}}$		19. Net sales per rupee of selling costs
6. $\frac{\text{Debt capital}}{\text{Equity capital}}$	(Equity ratio)	20. Advertising costs Selling costs
7. Earning per share		21. Operating profit per employee
		22. Overtime man hours
8. $\frac{\text{Dividend per share}}{\text{Price per share}}$	(Dividend yield)	23. $\frac{\text{Quantity of scrap}}{\text{Quantity of raw materials}}$
9. $\frac{\text{Value of direct material}}{\text{Value of production}}$		24. $\frac{\text{Quantity produced}}{\text{Total production capacity}}$
10. Direct material per worker		25. $\frac{\text{Cost of rejection}}{\text{Cost of production}}$
11. Output per worker		
12. Cost of production per hour		26. $\frac{\text{Power consumption}}{\text{Machine hours}}$
13. $\frac{\text{Idle time}}{\text{Total time}}$		27. Maintenance cost Cost of production

The particular ratios to be used in an inter-firm comparison scheme are selected carefully on the basis of (i) widest possible uniformity available among the different participating firms, (ii) the objectives for which inter-firm comparison is being made, and (iii) the individual problems and requirements of the participating firms. It may be emphasised here that the various terms should be properly defined so that the information submitted by the participating units will be sufficiently comparable. For the purpose of presentation, the median and the first and third quartiles are worked out in respect of the set of figures for every ratio. The data relating to a ratio received from the various units are arranged in order of magnitude from the lowest to the highest. The figures appearing at the mid-point and at one-fourth and three-fourths positions down this array or line of figures represent the median, and the first and third quartiles respectively. The

Firm Code Nos.	1	2	3	4	5	6	7	Median
1. Operating Profit/Operating Assets	11.2	6.3	6.7	3.6	8.2	8.5	5.6	6.3
2. Operating Profit/Sales	5.6	3.5	4.8	7.2	10.2	8.5	9.3	7.2
3. Sales/Operating Assets	2.0	1.8	1.4	0.5	0.8	1.0	0.6	1.0
4. Manufacturing Cost/Sales	85.3	80.2	78.5	82.1	76.5	81.4	75.0	80.2
5. Administration Cost/Sales	3.4	3.2	5.6	4.8	2.0	6.3	3.0	3.2
6. Selling & Distribution Cost/Sales	5.8	6.2	4.3	7.2	8.0	4.2	5.8	5.8
7. Material Cost/Manufacturing Cost	52.5	60.0	48.2	58.3	61.5	46.4	61.2	58.3
8. Wages Cost/Manufacturing Cost	12.8	14.6	16.5	20.8	14.8	15.9	11.2	14.8
9. Manufacturing Overhead/Manufacturing Cost	15.0	18.0	12.5	14.8	12.6	15.9	19.0	15.0
10. Total Assets/Sales	800	600	520	850	614	702	804	702
11. Current Assets/Sales	523	220	315	423	411	362	503	411
12. Fixed Assets/Sales	277	380	205	427	203	460	301	301
13. Material Stock/Sales	83	52	68	73	58	60	73	68
14. W-in-P Stock/Sales	10	25	30	15	22	41	37	25
15. Finished Stock/Sales	28	45	52	26	38	43	58	43

Fig. 13.2. Management Ratios for Inter-firm Comparison.

median represents the average after eliminating the effects of any extreme items, while the quartiles are indications for the participants to find out their own position in the range.

Figures in respect of each ratio are worked out on the above lines and presented to the participants together with their own individual figures. An illustration showing the form of presentation of ratios is given in Fig. 13.2. If firm code no. 4 be assumed to be the own concern, it will be seen that the profit of the concern is very low compared to the median. The reasons are low turnover, high cost of manufacture and high administration, selling and distribution costs. In turn, the high manufacturing cost appears to be due to high wage cost. The operating assets of the concern, both current and fixed, also stand at a higher level. An example illustrating the methods of calculation of various ratios is given below :

EXAMPLE 13.1

The Balance Sheet and Profit & Loss Account of Gofast Limited for the year ending 31st December 1982 are given below

Balance Sheet as on 31.12.82			
Liabilities	Rs.	Assets	Rs.
Equity Share Capital		Land & Building	2,85,000
80,000 Ordinary Shares of Rs. 10 each paid	8,00,000	Plant & Machinery	5,60,000
7% Pref. Share Capital		Furniture & Fixture	67,000
20,000 Shares of Rs. 10 each fully paid	2,00,000	Motor Vehicles	35,000
Reserves & Surplus	3,25,000	Investment at Cost	65,000
Unsecured Loans	2,40,000	Stock, Stores and Work-in-Progress	5,40,000
Sundry Creditors	4,35,000	Sundry Debtors	5,15,000
Outstanding Expenses	46,000	Bills Receivable	60,000
Provision for Taxation	80,000	Cash in hand	24,000
Proposed Dividend	1,10,000	Cash at Bank	85,000
Total Liabilities	22,36,000	Total Assets	22,36,000

Profit & Loss Account for the year ending on 31st December, 1982			
Dr	Rs.	Cr	R
To Opening Stock	1,50,000	By Sales	41,50,000
To Purchase	12,75,000	By Closing Stock	1,75,000
To Direct Wages	6,00,000		
To Factory Expenses	12,95,000		
To Gross Profit	10,05,000		
	43,25,000		43,25,000
To Selling & Distribution Expenses	5,20,000	By Gross Profit	10,05,000
To Administration Expenses	2,80,000	By Other Income	25,000
To Net Profit	2,30,000	(Interest)	
	10,30,000		10,30,000
To Provision for Taxation	80,000	By Net Profit	2,30,000
To Proposed Dividend	1,10,000		
To General Reserve Transfer	40,000		
	2,30,000		2,30,000

Note : 1. Depreciation has been fully provided.

2. Administration Expenses include Rs. 45,000 as Interest on borrowings.

From the aforesaid details and under Item 3 of the Annexure to the Cost Audit (Report) Rules, 1968, as a Cost Auditor of the Company -

(a) Determine Capital employed, Net Worth and Profit before Tax, and

(b) Calculate various Ratios as required under the Rules. (I.C.W.A., Final)

ANSWER :

<i>Capital Employed :</i>	Rs.	Rs.
Land & Building	2,85,000	
Plant & Machinery	5,60,000	
Furniture & Fixture	67,000	
Motor Vehicles	35,000	
	<hr/>	
Total Fixed assets		9,47,000
Stock, Stores & Work-in-Progress	5,40,000	
Sundry Debtors	5,15,000	
Bills Receivable	60,000	
Cash in hand	24,000	
Cash at Bank	85,000	
	<hr/>	
Total Current Assets		12,24,000
		<hr/>
Total Assets at book value		21,71,000
Sundry Creditors	4,35,000	
Outstanding expenses	46,000	
Provision for Taxation	80,000	
Proposed dividend	1,10,000	
	<hr/>	
Total Current liabilities		6,71,000
		<hr/>
Capital employed		15,00,000

Net Worth

	Rs.
Preference Share Capital	2,00,000
Equity Share Capital	8,00,000
Reserves & Surplus	3,25,000
Net Worth	<hr/> 13,25,000

Profit (before tax)

Net profit as per Profit & Loss Account	2,30,000
Add : Interest on borrowing	45,000
	<hr/> 2,75,000

Deduct : Interest & Other income

	25,000
Profit before tax	<hr/> 2,50,000

(i) Profit on Capital employed	Rs. 2,50,000 Rs. 15,00,000	$\times 100 = 16.67\%$
(ii) Profit to Sales	Rs. 2,50,000 Rs. 41,50,000	$\times 100 = 6.02\%$
(iii) Current Assets to Current Liabilities	Rs. 12,24,000 Rs. 6,71,000	$\times 100 = 182.4\%$
(iv) Net worth to long term borrowing and liabilities	Rs. 13,25,000 Rs. 2,40,000	$\times 100 = 552.1\%$
(v) Net worth to Capital employed	Rs. 13,25,000 Rs. 15,00,000	$\times 100 = 88.3\%$

$$(vi) \text{ Cost of Production to Capital employed} = \frac{\text{Rs. } 33,80,000}{\text{Rs. } 15,00,000} \times 100 = 225\%$$

Cost of production is calculated as follows :

Opening Stock	1,50,000
Add : Purchases	12,75,000
Deduct : Closing stock	1,75,000

Consumption of Materials	12,50,000
Direct wages	6,00,000
Factory Expenses	12,95,000

Factory Cost 31,45,000

Add : Administration Expenses 2,35,000 (Excluding Rs. 45,000 as interest charge)

Cost of Production 33,80,000

$$(vii) \text{ Cost of Production to Working capital} = \frac{\text{Rs. } 33,80,000}{\text{Rs. } 12,24,000} \times 100 = 276\%$$

Advantages of Inter-Firm Comparison. A scheme of inter-firm comparison combines the advantages of a uniform costing system and the benefits arising out of the use of ratios. The advantages of uniform costing were discussed in a previous section of this chapter. The following additional advantages are obtained from inter-firm comparison :—

- (i) Inter-firm comparison makes the management aware of its strength or weakness in relation to others in the industry. If some ratios do not show a favourable trend, further probing is done in regard to other ratios till the causes leading to weakness are revealed. Remedial action may be taken thereafter to improve performance.
- (ii) Only significant facts are reported to the management. Ratios which do not vary significantly from the norm may be ignored and efforts concentrated only on a few ratios.
- (iii) Information about the industry is made available without the fear of disclosure of data of a confidential nature.
- (iv) Specialised knowledge and experience of the central organisation are available. A fund of statistics is offered and reporting of figures and interpretation thereof is made on a specialist's lines.
- (v) The industry as a whole benefits due to increased productivity, standardisation of methods, and elimination of unfair competition and weak selling. Reliable data enhance the bargaining power of the concerns in dealing with the Government and other parties.
- (vi) Inter-firm comparison assists in identification of industrial sickness and gives the warning signal on time so that remedial measures may be taken before the breaking point is reached. Numerous external and internal factors contribute to the sickness of an industrial unit but the general indications of an impending sickness in a unit are :
 Drop in production and reduced productivity ;
 Slow movement of stocks
 Huge inventory build-up
 Abnormal increase in debtors ;

Delay in payment of labour and government dues for want of funds ;
Frequent resort to loans; frequent requests for additional limits on overdrafts ;

Non-payment or delayed payment of sundry creditors ;

Non-payment of interests due ;

Irregular depreciation ;

Fall in profit margin ;

Lower dividend ;

Fall in market price of shares ; etc. etc.

The impact of the above signal is reflected in the management ratios compiled for the purpose of inter-firm comparison. For instance, quantity produced in relation to total production capacity, wages per employee and output per worker will point out any fall in production or productivity, the current and the quick ratios will indicate the position of liquidity of the firm, the increase in the average number of days of collection will show an adverse position so far as credit collection is concerned, a reduced inventory turnover will indicate the reduction in the velocity with which inventory moves in the concern and the build-up of heavy inventory and so on.

Limitations of Inter-Firm Comparison and the Difficulties involved in its Implementation. The main limitation of inter-firm comparison methods arises due to the difference in the nature of the participating units. This makes comparatively difficult and in such cases, the ratios are likely to be ineffective. Efforts should, therefore, be made to arrive at fundamental uniformity in the matter of accounting methods and in the presentation of results.

The practical difficulties that are likely to arise in the implementation of a scheme of inter-firm comparison are :

- (a) The top management may not be convinced of the utility of inter-firm comparison.
- (b) Reluctance to disclose data which a concern considers to be confidential.
- (c) A sense of complacency on the part of the management who may be satisfied with the present level of profits.
- (d) Absence of a proper system of cost accounting so that the costing figures supplied may not be relied upon for comparison purposes.
- (e) Non-availability of a suitable base for comparison.

These difficulties may be overcome to a large extent by taking the following steps :

- (i) 'Selling' the scheme through education and propaganda. Publication of articles in journals and periodicals, and lectures, seminars and personal discussions may prove useful.
- (ii) Installation of a system which ensures complete secrecy.
- (iii) Introduction of a scientific cost system.

EXAMINATION QUESTIONS

1. Uniform costs are generally regarded as costs possessing the maximum degree of inter-business comparability. How is this comparability achieved? What are the conditions desirable for its application?

(I.C.W.A., Final)

2. To ensure effective price control the Government desires that different units of a certain industry should follow uniform costing methods.
What are the points of agreement on principles, which different units should conform before they adopt uniform costing procedure. *(I.C.W.A., Final)*
3. The members of a federation of manufacturing concerns have agreed to have uniform method of costing in their concerns. As a Cost Accountant of the federation, what principles would you decide to be followed in order to achieve the object of proper comparison of cost, before introducing the uniform method of costing?
(I.C.W.A., Final)
4. Define 'uniform costing'. What are the fundamental principles that will require to be decided upon before a uniform costing system can be devised for member concerns in an industry?
List three industries in India where uniform costing system can be employed with advantage. Give reasons. *(I.C.W.A., Final)*
5. It is considered desirable to develop and apply uniform costing methods in the various steel plants in the country, taking due note of the difference in the size and process of production in the units. Give a broad outline of the major steps to be taken for the successful introduction of uniform cost accounting in this field. *(I.C.W.A., Final)*
6. You have undertaken an investigation on behalf of a trade association in order to establish the possibility of recommending uniform costing methods for the trade, and you are satisfied that such methods are practicable. You are next called upon to write a uniform costing manual for circulation to members of the association.
Draft a schedule of main and sub-headings for the manual and indicate briefly the points to be covered under each heading. *(I.C.M.A., Final)*
7. A manufacturing company has three textile mills—one each in Calcutta, Bombay and Delhi—producing entirely different types of textiles. Discuss to what extent uniform cost accounting methods could be of advantage under such circumstances.
(I.C.W.A., Final)
8. State as fully as possible what you consider are the advantages and disadvantages of uniform costing to (a) an individual firm (b) an industry, and (c) the public.
(I.C.M.A., Final)
9. You are the Cost Accountant of a cement company having six different cement factories all over India, and want to introduce a system of uniform costs. Write a short note to your manager outlining the advantages of doing so. *(I.C.W.A., Inter)*
10. The Managing Director of a Company which has factories located at various places in India, feels that he is not getting adequate information about their relative performance though in each factory there is a good accounting and costing system. Write to him a report outlining a system of intra-firm comparison and analysis of certain key ratios in order to assess the relative performance of the various factories.
(I.C.W.A., Final)
11. What are the purposes of inter-firm comparison? What procedure would you follow for this?
(I.C.W.A., Final)
12. To what extent can inter-firm comparison be made useful in the case of concerns which differ widely in size and methods of production and sales? Outline the preliminary steps to be taken for employing a scheme of inter-firm comparison for a group of such concerns.
(I.C.W.A., Final)
13. How would information available from published accounts of Joint Stock Companies be used by you as a Cost Accountant for comparing with performance of your company and suggesting improvement of profitability?
(I.C.W.A., Final)
14. How could inter-firm comparison be made useful for the measurement of productivity?
(I.C.W.A., Final)
15. Sickness in industry is not a sudden phenomenon. Early symptoms can always be detected and remedial measures taken to prevent sickness. Discuss with examples how far the study of accounting ratios and inter-firm comparison helps in this direction.
(I.C.W.A., Final)

16. You have the following information on the performance of Prosper Co., as also the industry averages.

(a) Determine the indicated ratios for Prosper Co.

(b) Indicate the Company's strengths and weaknesses as shown by your analysis.

Balance Sheet as on 31.12.1982

	Rs.		Rs.
Equity Share capital	24,00,000	Net Fixed Assets	12,10,000
10% Debentures	4,60,000	Cash	4,40,000
Sundry Creditors	3,30,000	Sundry Debtors	5,50,000
Bills Payable	4,40,000	Stocks	16,50,000
Other Current Liabilities	2,20,000		
	<hr/>		<hr/>
	38,50,000		38,50,000
	<hr/>		<hr/>

Statement of Profit for the year ending 31.12.1982

	Rs.	Rs.
Sales		55,00,000
Less : Cost of goods sold :		
Materials	20,90,000	
Wages	13,20,000	
Factory Overheads	6,49,000	40,59,000
	<hr/>	<hr/>
Gross profit		14,41,000
Less : Selling and Distribution cost	5,50,000	
Administration and general expenses	6,14,000	11,64,000
	<hr/>	<hr/>
Earnings before interest and taxes		2,77,000
Less : Interest charges		46,000
		<hr/>
Earnings before taxes		2,31,000
Tax		1,15,500
		<hr/>
	Net Profit	1,15,500
		<hr/>

Ratios Considered

	Industry
Current assets/Current liabilities	2.4
Sales/Debtors	8.0
Sales/Stocks	9.8
Sales/Total assets	2.0
Net Profit/Sales	3.3%
Net Profit/Total assets	6.6%
Net Profit/Net worth	10.7%
Total Debt/Total assets	63.5%

(I.C.W.A., Final)

CHAPTER 14

COST AUDIT AND MANAGEMENT AUDIT

COST AUDIT. Cost audit is defined as the verification of cost accounts and a check on the adherence to the cost accounting plan. It will be seen from the definition that cost audit performs two functions. The first function is to verify that the cost accounts have been correctly maintained and compiled according to the cost accounting system employed by the concern. The second function is to see that the costing plan laid down, i.e. the prescribed routine of cost accounting is carried out. A third objective of cost audit, which in fact is the purpose of all types of audit, is to detect errors and prevent fraud and misappropriation.

The cost accountant plans the system of cost accounting. He selects a method of costing most suitable for the business, lays down the various routines and procedures to be followed, and designs the forms and documents to be used for the collection, allocation, and apportionment of costs and the presentation of results in an appropriate manner. The best of the plans will not, however, succeed unless it is rigidly followed and action is taken to implement it on proper lines. Important decisions made by the management sometimes involve heavy financial outlay. Unless it is ensured that the figures furnished by the cost accountant are correct and accurate and are worked out in a manner consistent with the plan, the decisions based upon unreliable cost data may lead to serious consequences. Errors, inconsistencies, malpractices, and fraud in compiling and furnishing data make a costing system ineffective. In all costing procedures there is the usual provision that one set of figures be automatically cross-checked with another in order to ensure accuracy, and sometimes the work done by one clerk may be checked by another as a matter of routine. But all these cannot be foolproof methods and it is only an independent system of cost audit that can prove to be effective safeguard against errors and deviations from the preconceived plans.

Types of Functional Audit. The various types of functional audit may be classified as follows :

(i) *Propriety Audit* : Propriety audit, sometimes also known as *Higher audit*, is concerned with the audit of such actions and plans of the management which have a bearing on the finances and expenditure of the concern. An item of expenditure may have been properly sanctioned and it may be duly supported by vouchers. Yet it may not be able to satisfy propriety audit if the wisdom of the management in incurring the expenditure is challenged. Propriety audit judges whether or not a particular expenditure would give optimum results and whether any other plan could better these results. It questions all expenditure to find out whether any unsound decision was taken due to error of judgement or such other reasons, that was not in the best interest of the company. In this manner, propriety audit safeguards the tax payers' money and the share-holders' capital.

(ii) *Efficiency (or Performance) Audit* : Efficiency audit consists of the appraisal of performance to determine whether the plan has been executed efficiently. It is not enough to see that expenditure is incurred according to the plan but that the results obtained are as they were planned. Broadly speaking, efficiency audit starts with the examination of the plan (which may, for instance, be in the form of financial or other functional budgets), and extends to the comparison of the actual performance against the plan and the investigation into the reasons for variances. Such comparisons may also be made with reference to the performances during different periods or may be extended to inter-firm comparison between units of the same industry or of different industries.

Efficiency audit is of particular significance in industrial concerns, and it ensures that real economy has, in general, been effected in all the spheres in the business ; every rupee invested in capital or other fields yields the optimum return and the investment in different spheres is balanced, adequate, and optimum. Efficiency audit also checks up whether job evaluation and merit rating have been introduced on correct lines and are being rigidly adhered to.

(iii) *Operational Audit* : Operational audit appraises the activities of each operational area of the business, such as production, engineering, sales, accounting, administration etc., in relation to the overall objective of the concern. It also checks whether the control systems introduced for the various business operations are working satisfactorily, the aim being to improve the system and the operations, wherever possible.

(iv) *Voucher Audit* : Voucher audit is primarily an integrity or honesty audit carried out with reference to vouchers. This is the basic routine check which ensures that the transactions of a business are correct and truthful and are duly supported by vouchers, receipts, etc. A transaction is considered to be valid only if it is supported by a voucher which should be in the proper form drawn in a proper manner and properly authenticated.

(v) *Regulation Audit* : In Government departments and Statutory bodies, sets of rules and regulations are prescribed which govern the day-to-day operation of these organisations. In the private sector also, drills and manuals lay down the detailed procedure to be followed in respect of items and transactions which are not already covered by Government legislations like the Companies Act, various Labour Laws, etc. Regulation audit ensures that these rules and procedures are correctly and faithfully adhered to.

(vi) *Statutory Audit* : Audit conducted in accordance with the provisions of any Act or Statute laid down by the Government is termed Statutory audit. The Companies Act (Sec. 224) requires that the prescribed books and accounts maintained by a company be audited by specially appointed auditors. The statutory auditor ensures and satisfies himself that the company's accounts have been correctly compiled so as to exhibit a fair and true view of the affairs of the company. This audit is normally confined to the audit of the financial accounts of the company, i.e. its Profit and Loss Account and Balance Sheet and the accounts and documents leading to their compilation.

An amendment of the Companies Act, 1956, (Sec. 233B) has made the audit of the cost accounts of certain establishments (to be notified by the Central

Government from time to time) compulsory. Statutory audit of companies now, therefore, covers the financial as well as the cost accounts of those companies.

Statutory audit of the accounts of the Government departments and statutory bodies is conducted by the representatives of the Comptroller and Auditor General who is directly responsible to the Parliament.

(vii) *Social Audit* : The duties and obligations of man as a social being have been recognised through ages. The concept that has grown now is that because of its operation within the four walls of the society, a business, like an individual, is also a social entity and as such it should be bound by certain social codes and should be made to discharge its responsibilities towards society. The primary objective of a business is, no doubt, to run the organisation economically in such a manner as to maximise profit but in addition to the operational and commercial functions which it performs to achieve its objective, it should take such actions that would benefit the society. Some of these actions may be :

- (a) Maximising production, reducing costs, and improving quality of products. These would benefit the consumer who will have uninterrupted flow of goods in his hands at reasonable prices.
- (b) Maintaining industrial peace and working on such projects that would generate more employment.
- (c) Development of backward areas.
- (d) Welfare measures for employees and their dependants. These would include training, education, health schemes and recreation facilities.
- (e) For the community : Spreading education and literacy, rural uplift, adoption of villages, furtherance of cultural pursuits, etc.
- (f) Anti-pollution measures and maintenance of ecological balance.
- (g) Donations and charity.
- (h) Building estate and township.

While some of the measures enumerated above will not impose any financial burden on the business, most of the actions would involve costs ; *social costs* as these are termed. Social audit covers both cost and non-cost aspects of social performance and in addition to the usual routine of checks over expenditure, oversees ;

- (a) how far the social obligations have been met, and
- (b) whether costs incurred have been commensurate with the benefit rendered to the society (social cost-benefit analysis).

Internal Audit. Audit may be external, i.e. conducted by outside parties or organisations, or it may be internal, i.e. conducted by persons who are in the employ of the business. External audit may be performed under orders of the Government, by necessity, or by choice. Statutory audit is, as a rule, carried out by outside auditors who are not regular employees of the concern. Sometimes, a firm of auditors or consultants may be requested by the management to conduct the audit of a specific sector of the business or to carry out an audit investigation for a specific purpose.

Most concerns have their own staff for internal audit. The scope and objectives of internal audit vary in different concerns according to the requirements of the management. In some undertakings, the internal auditor and the cost auditor are two separate individuals entrusted with separate duties and

responsibilities, while in some others, both functions are combined and performed by one and the same person, viz. the internal auditor.

Internal audit carries out an appraisal of all the activities of a concern or of a part thereof, as desired. It assists the management, particularly the top level management in ensuring that the business is running according to plan. The main objectives of internal audit are summarised below :

- (i) It ensures by vouching, the correctness of accounting transactions and data, and exercises checks to see that budgets have been correctly drawn up. It detects errors including errors of principle.
- (ii) It detects and prevents fraud.
- (iii) It ensures that accounting is done promptly and according to schedule.
- (iv) It improves personnel efficiency.
- (v) It facilitates cost control by checking up whether the prescribed control plans, procedures, and policies are properly adhered to at all levels of management and remedial measures are taken promptly.
- (vi) It carries out a continuous appraisal of the accounting system and focuses attention on the weaknesses of the system. It pin-points lacunae and loopholes so that points of wastage and excess expenditure may be plugged in. The appraisal assists the management in toning up general administration.
- (vii) It watches whether the policies laid down are properly communicated to lower levels, and errors, inefficiencies, and deviations from the norms are reported without delay to the higher levels of management so that responsibility may be promptly fixed.
- (viii) It verifies the physical existence of stock and assets.

The routine of internal audit includes, (i) the review of the organisation, procedures, and methods, (ii) audit of assets and liabilities like cash, inventory, sundry debtors and creditors, fixed and other assets, loans, share capital, and reserves, and (iii) audit of income and expenditure.

Internal Audit vis-a-vis Statutory Audit (or External Audit). Though the internal auditor and the statutory auditor operate with common interests in the field of accounting, and both of them apply similar methods like examining the internal checks, vouching, verification, and observation, there are some basic differences between the two. The features which distinguish internal audit from statutory audit may be summarised as follows :—

- (i) The scope of work of internal audit is usually wider and is laid down by the management, whereas the work of statutory audit is limited to that stipulated by the Statute. An internal auditor goes into detailed investigation and unlike the statutory or external auditor, his function is not limited to simple verification and checking but he also comments on the efficiency and nature of the management.
- (ii) It evidently follows that the internal auditor is responsible to the management but the statutory auditor not being an employee of the concern, is independent and is responsible to the shareholders only.
- (iii) The methods of approach of internal audit and statutory audit are different. The internal auditor concentrates on internal control and internal checks and gives attention mainly to prevention and detection of errors and frauds.

- (iv) Internal audit is not compulsory and a business is not bound by law to employ internal auditors.
- (v) Internal audit is helpful for external audit ; it furnishes important technical and accounting information. The external auditor may not have to go into detailed checking of items already covered in internal audit.
- (vi) Internal audit may be concurrent or continuous. Though responsible for complete audit, external audit may be satisfied with only percentage or test audit if a reliable system of internal audit exists in the business.

Internal Audit and Internal Check. Sometimes, internal check is confused with internal audit. Although both internal audit and internal check constitute parts of the complete system of internal control established for the efficient conduct of the business, the meaning and scope of the two are quite distinct. While internal audit refers to the wider functions which are performed by specialist internal auditors, internal check refers to a narrower field and is limited to purely routine tests and checks carried out for the purpose of detection of errors, malpractices, fraud, etc. Internal checks form a part of the duties of the internal auditor but even in those concerns where there is no comprehensive system of internal audit, there would be some sort of a system that would ensure, through internal checks, the accuracy of the financial transactions, and the accounting data. Internal checks are exercised in accordance with certain *basic principles*, some of which are as follows :—

- (a) Work done by one individual is checked by another. The check may be carried out by the senior staff and may either be a complete check or only a sample test check.
- (b) A cycle of work is so divided and distributed that work from one stage is passed on to another individual for independent check and further processing. This also obviates the risk of manipulation of posting in documents, ledgers, etc., which is present when one individual handles more than one stage of a work.
- (c) Authority to sign documents such as materials requisitions, invoices, cheques, etc., to handle stores and cash, and to incur expenditure is clearly defined. A list of individuals who are delegated authority for different purposes should be maintained.
- (d) There is a system of reconciliation of physical balances (of stores, cash, etc.) with the ledger or book balances.

Scope and Functions of Cost Audit. Cost audit is concerned mainly with propriety and efficiency audit. It attempts to ascertain the profitability of the concern and to improve it. Cost audit covers the entire field of costing, cost control, and cost presentation in an undertaking. Some of the areas which may be examined by the cost auditor are detailed below :

1. *Inventory of Stores and Work-in-Progress*

- (i) Size of the inventory vis-a-vis the production programme ; need for reduction in size. The opening stock of stores should be commensurate with the volume of production.
- (ii) Efficiency of the provisioning procedure. An economical procedure for provisioning should take into account the following :—
 - (a) Storage cost as against carrying cost.

- (b) Optimum order size.
- (c) Lead time.
- (iii) Adequacy of the procedure adopted for obviating possibilities of loss or pilferage of materials lying in Stores and Shops.
- (iv) Reasonableness of quantity of scrap, waste, etc. arising in course of manufacture.
- (v) Proper system of return of scrap and waste arising in production to Stores and their correct allocation/credit to the production orders against which they arise. In case of transfer of materials from one job to another, the correctness of the transfer voucher should be examined. Transfer vouchers and other stores adjustment documents should be properly authorised and immediately recorded.
- (vi) Scientific method of issue of materials from Stores to production shops. All issues should be properly authorised and all materials requisitions checked before issue of materials. Consumption of indirect materials and consumable stores should be within the standard or budgets.
- (vii) The method of pricing of issues ; whether pricing is correctly done in accordance with the method prescribed.
- (viii) Posting of documents, e.g. materials requisitions and goods received notes in stores ledger and bin cards on a day-to-day basis.
- (ix) Correct valuation of closing stock and its exhibition in the Trading and Profit and Loss Accounts and Balance Sheet.
The following points in regard to stock in hand should be seen :
 - (a) Whether physical stock verification is correctly carried out.
 - (b) Whether the closing stock is priced correctly in accordance with the prescribed procedure of valuation.
 - (c) Whether the non-moving store is normal compared to the average rate of consumption. If not, whether proper action for disposal of surplus stores has been initiated.
- (x) Accurate physical verification of stock of work-in-progress, which should agree with the cost records.
- (xi) Correct valuation of the work-in-progress with reference to the stage of completion of a job or process and the expenditure booked in the cost cards.
Tendency to vitiate valuation of work-in-progress so as to manipulate profits should be detected.
- (xii) Reasonableness of the volume of work-in-progress in comparison to the value or volume of finished production.
- (xiii) Correct computation of material usage and price variances.

2. Labour

- (i) Maximum utilisation of labour and reduction of labour cost. (This covers both manual and machine hour utilisation).
- (ii) Measurement of the efficiency of production and productivity, and comparison with standards or norms in order to take corrective actions promptly.
- (iii) Correct booking of labour cost with regard to job/time cards or tickets. Correct classification into direct labour costs.
- (iv) Agreement of gate time with job time.
- (v) Revealing of idle capacity.
- (vi) Effect of working overtime and in shifts.
- (vii) Accuracy of calculation of wages from job cards and time-sheets.
- (viii) Precautions against irregularities and fraud in wage payment.

3. Overhead

- (i) Proper classification and booking of expenditure in accordance with the prescribed methods.
- (ii) Preparation of overhead budgets on correct lines.
- (iii) Comparison of actual expenditure with budgets or standards in order to see that there are no significant variations and that all variations are explained, accounted for, and remedial measures taken.
- (iv) The amount of overhead expenditure compared to the volume of output.

- (v) Correct allocation or apportionment of overhead expenditure to production, administration, selling and distribution ; allocation to producing and service cost centres ; apportionment from service cost centres to producing cost centres, and recovery of overhead from cost units at correct rates.
 - (vi) Correct allocation of overhead expenditure to work-in-progress.
4. *Selling, Distribution, and Administration Expenses*
- (i) Careful preparation of budgets after making a proper market study.
 - (ii) Performance evaluation to see results of market study.
 - (iii) Scrutiny to see whether actuals deviate from the budgets or standards.
 - (iv) Size of advertising expense and justification for it.
 - (v) Size of sales and distribution expenses in relation to production and market.
5. *Capital Expenditure*
- (i) Propriety and authority for procurement of new plants and machinery and buildings.
 - (ii) Correctness of accounting of expenditure with reference to vouchers, capital orders, etc.
 - (iii) Accounting of purchase cost and charges for transport, erection, etc., to capital heads.
 - (iv) Proper maintenance of plant records.
 - (v) Discarding of old assets.
 - (vi) Correctness of depreciation rates and their calculations.
 - (vii) Physical verification of fixed assets.
6. *Utilization of Capacity, Plant and Equipments*
- (i) Justification or reasonableness of idle capacity.
 - (ii) Reasonableness of the expenditure on tools (whether tool costs are properly charged to production costs proportionate to the services rendered).
 - (iii) Optimum utilisation of resources ; investigation of reasons for non-utilisation.
 - (iv) Reasonableness of expenditure on maintenance, repairs, replacement, etc.

Cost Audit and Financial Audit Compared. The primary function of cost audit and financial audit is the same as that of any audit, namely to carry out an independent scrutiny of the relevant accounts of an organisation. The basic principles adopted are common to both types but they differ from each other in the methods of approach and the purpose they are required to serve. As audit follows accounting, financial audit covers the financial accounts just as cost audit covers the cost accounts. Besides, there are certain particular features which distinguish cost audit from financial audit. These are :

- (i) Financial audit is more of a honesty audit. It aims at securing the correctness of the recording and accounting of transactions through vouching. The procedure consists of 'vouching' and 'ticking' all transactions appearing in various forms, documents, and vouchers. Cost audit, however, mainly lays stress on propriety of expenditure and efficiency of performance.
- (ii) Except for the final profit and loss account and the balance sheet, financial audit is not concerned with the forms of the various primary accounts from which these two are built up. Cost audit goes into the designs of forms, records, and documents. Financial audit is usually a postmortem check to see that expenditure recorded as having been incurred has actually been incurred. It is concerned with past data only and has no suggestions to make for the future. On the other hand, cost audit has a forward approach.
- (iii) The basic differences in the accounting approach to certain cost factors such as in the matter of valuation of stock and treatment of items like interest, depreciation, under- or over-absorbed overheads,

deferred revenue expenditure etc. are reflected in the difference in the approach of cost audit and financial audit.

Advantages of Cost Audit. The objectives of a system of cost audit and the advantages derived from it are given below :

For the management

- (i) As in the case of any system of audit, cost audit assists in detection of errors and malpractices. Concurrent or continuous cost audit prevents manipulation and fraud.
- (ii) The cost data gain a high degree of reliability. The audited figures provide reliable data for the preparation of accurate cost reports and returns for presentation to the parties interested. The inventory valuation as certified in cost audit ensures its correctness and integrity.
- (iii) Cost audit results in improved cost accounting methods and better internal control.
- (iv) The useful disclosures made in the cost audit reports create cost consciousness in the management.
- (v) Cost audit improves the effectiveness of cost control and cost presentation. By pinpointing avoidable wasteful routine and procedures and by recommending the introduction of an efficient cost routine in conformity with modern techniques, cost audit reduces the expenditure on cost accounts and ensures promptness in its preparation.
- (vi) Cost audit leads the management to initiate action for economic and efficient usage of labour, material and other resources, towards achieving higher productivity and for higher utilization of capacity.
- (vii) Audited cost data is helpful in inter-firm comparison.
- (viii) Cost audit may identify the symptoms of sickness in a unit, thus enabling remedial measures to be taken in time to prevent the sickness.

For the Cost Accountant

- (i) Report on the accuracy and correctness of cost compilation raises the status of the cost account.
- (ii) Where cost audit is external, the auditor with his varied experience of various industries may assist the cost accountant in improving cost methods and can solve specific problems intended to raise the efficiency of the cost department.
- (iii) Cost audit tends to make the staff more careful and accurate in their work.

For the shareholders and the tax-payers

- (i) Cost audit exercises a check on the correctness and adequacy of the valuation of inventory and work-in-progress. Financial audit or Statutory audit is satisfied if the valuation is certified by the management.
- (ii) External cost audit highlights the following features for the benefit of the shareholders or taxpayers :—
 - (a) Efficiency or otherwise of management.
 - (b) Proper utilization of resources.
 - (c) Productivity of labour, material, and machines.
 - (d) Weak or strong points in the organisation.

For the Government and consumers concerned

- (i) In the case of cost-plus contracts entered into by the Government with concerns, cost audit ensures the correctness of the cost data so that the settlement of bills is made quicker and easier.
- (ii) Cases for tariff protection can be forcefully put forth if backed by audited cost figures from which excess, abnormal, and avoidable expenses have been weeded out.
- (iii) Correct data are readily available for price fixation by the Government on a rational basis. Cost audit assists in the formulation of policy on administered prices.
- (iv) Cost audit of weak, inefficient, or mismanaged units in the industry reveals important information which may be used for taking proper corrective action.
- (v) Where escalator clauses are in operation in respect of certain contracts, the contractee is sure of the audited cost data on which he may safely rely.
- (vi) By locating areas where increase in productivity can be achieved and performance can be improved, cost audit contributes to the betterment of the national economy. In short, cost audit ensures that the social and economic objectives of national planning are achieved.

Planning the Organisation and Programme for Cost Audit. Practices followed by concerns with regard to cost audit vary widely. Cost audit may be either partial or complete ; it may be confined, particularly in small concerns, to only a test check of some or all the items and aspects of the system. The audit may be carried out periodically in some concerns, while others would prefer to have a continuous and concurrent audit. The work may be entrusted to outside or external auditors or in case of well managed large concerns, a team of internal auditors may be permanently employed in the business for the purpose. In some concerns, there is no separate department for cost audit ; the duties are entrusted to one or two auditors attached to the existing internal audit department. Thus, the type and size of the organisation for cost audit that would be suitable for a business, will depend upon the above mentioned factors and no standard pattern can be laid down.

When planning the programme/procedure for cost audit and deciding the size and type of organisation, number of auditors required, etc. the following points are to be considered and examined :—

- (a) The objects of the proposed audit, i.e. whether the audit is to be limited to checking of errors and detection of fraud, or it is to cover a wider field incorporating audit of the system, propriety audit, and efficiency audit. It would also be relevant to see whether the cost audit is to be conducted externally or internally.
- (b) The system of cost accounting employed in the concern. The system organisation, charts, forms, schedules, accounts etc. should be studied and flow charts and diagrams should be examined.
- (c) The system and extent of internal check applied in the concern.
- (d) The extent of audit necessary and whether in any particular segment, partial and not complete audit is necessary. A decision on the point will depend upon the efficiency of the internal check system in vogue. If

partial audit is to be conducted, the extent and type of test to be carried out should be specified.

- (e) **The frequency of audit.** The frequency depends upon several factors like the object of audit, areas to be covered, volume of transactions, efficiency of internal check, needs of the management, and whether the audit is to be external or internal. Stress should be laid on the audit of the important sectors by increasing the frequency of audit for items relating to those sectors. If the volume of transactions is heavy, continuous audit may be carried out without any break in its continuity. Another method, which is suitable when the number of transactions is not so large, is to have an interim audit within the audit period. This may be carried out at regular intervals or occasionally, as desired. Interim audit at irregular intervals offers an additional advantage as it has an element of surprise associated with it. Continuous audit helps in keeping work and records up-to-date, obviating malpractice and manipulation of records, prompt location and check of errors and fraud so as to avoid recurrence, and speedy completion of final audit after the close of the audit period. It also assists the management in declaring interim dividends and valuing goodwill for the purpose of transfer, sale, amalgamation, etc.

After consideration has been given to the above points, a suitable programme for cost audit is made out. The procedure and programme to be adopted for audit and the various forms and the documents used for it should be laid down in an *Audit Manual*. The audit programme should be drawn out in detail, specifying each item of audit work to be carried out. For example, the various areas of audit listed on Pages 718-20 may be further broken up into smaller tasks to constitute an audit programme, as illustrated below.

Cost Audit Programme

General :

- (1) Check whether all routine procedures as laid down are adhered to.
- (2) Ensure that all records and documents are prepared as prescribed.
- (3) Check whether instructions regarding delegation of authority are carried out, e.g. documents are signed only by the proper authorised persons.

Material

- (1) Check the serial number control of material documents, i.e. purchase order, inspection note, goods received note, materials requisition, materials return note, materials transfer note, etc.
- (2) Compare the quantity received as indicated in the supplier's or carrier company's challans with the quantity as per goods received note and inspection note. Verify that goods returned to suppliers have been properly acknowledged.
- (3) Verify the quantity posted in the relevant bin cards.
- (4) Compare the rates in the supplier's bills with those in the purchase orders.
- (5) Check the calculation of rates of issues.
- (6) Verify the authority for issue of materials.
- (7) Check the correctness of rates quoted on materials requisitions, and materials return and transfer notes.

- (8) Check the correctness of valuation, (i.e. quantity multiplied by rate per unit) of materials requisitions, and materials return and transfer notes.
- (9) Check the correctness of a materials issue analysis.
- (10) Verify posting of costs of materials requisitions, and materials return and transfer notes on job or process cost sheets.
- (11) Check the posting and balancing in the stores ledger.
- (12) Check the transfer entries made in respect of cost variation accounts in case of variances from standard costs.
- (13) Check and verify the loan transactions. Verify confirmation received from the parties to whom materials are loaned.
- (14) Test check physical inventory and verify the basis of valuation of stock of raw materials, work-in-progress, and finished stock.
- (15) Verify the records of receipts and issues of tools, jigs, and fixtures and verify stock and basis of stock valuation.

Labour :

- (1) Verify the booking of attendance of workers.
- (2) Check the accuracy of booking of time to jobs.
- (3) Check the reconciliation of time keeping and time booking.
- (4) Verify the correctness of calculation of wages (including allowances, bonuses, etc.) and recoveries.
- (5) Check the system of handling and controlling physical cash and of actual disbursements of wages.
- (6) Check the correctness of classification of labour into direct and indirect.
- (7) Verify the correctness of the wages analysis sheets or wages abstracts.
- (8) Verify the posting of labour cost to job and process cost sheets.
- (9) Check the transfers made to cost variance accounts in respect of variances from standard costs.

Overhead :

- (1) Check the classification of overhead.
- (2) Verify the booking of overhead to Standing Order Numbers and to departments.
- (3) Check the allocation and apportionment of overhead costs to producing departments.
- (4) Verify the correctness of calculation of overhead recovery rates and the charges made to various jobs, etc.
- (5) Verify the correctness of accounting of cost of idle time of workers and machines.
- (6) Check the calculation of depreciation and its charge to accounts.
- (7) Check transfers to variance accounts in case of deviations from budgets or standards.
- (8) Scrutinize the extent of under- or over-absorbed overhead and their disposal.
- (9) Verify allocation of cost to capital, revenue, and deferred revenue.
- (10) Compare actual administration, selling, and distribution expenses with the budgets and check the extent of variances.
- (11) Check items not included in cost accounts and verify reconciliation of cost and financial accounts.

Miscellaneous :

- (1) Verify postings of materials, labour, overhead, and the total costs on cost sheets and compare with standards or estimates.
- (2) Check correctness of postings in fixed assets registers.
- (3) Verify records of loose tools, spare parts etc.
- (4) Make inter-period and inter-firm comparisons of costs.
- (5) Scrutinize excess stock of raw materials, work-in-progress, and tools.
- (6) Compare actual sales with the estimates or budgets.
- (7) Examine the correctness of standards or budgets and the necessity for their revision.

The *advantages* of an audit programme are :

- (i) It assists in the delegation and distribution of work to junior staff. On completion, each item of work done may be initialled by the junior auditor/clerk concerned.
- (ii) It provides a plan for systematic and methodical audit check ensuring at the same time that no item is left out.
- (iii) It assists in completion of audit by the due date.
- (iv) The audit programme duly initialled by the auditor may, if required, be considered as a documentary evidence of the work done.

Before the audit work is taken up, all books and records should be posted up-to-date, vouchers for the various transactions filed serially and all working sheets made available to the auditors. The prior assembly of such information saves the auditor's time and reduces cost. Audit should be conducted with utmost co-operation of the staff. Whatever be the nature and type of audit conducted, it follows a general pattern and the following principles and important factors are common to all types.

1. *Vouching*. Vouching refers to the inspection by the auditor of the documentary evidence which substantiates a financial transaction. In vouching, the auditor notes the correctness of an individual transaction posted from supporting documents. For example, vouching would mean a check to see that issue of materials is backed by materials requisitions. Vouching also consists in ensuring that the voucher has been finally posted to the particular document, ledger, or book of accounts in which it was required to be entered according to the prescribed procedure. The voucher itself should be scrutinized to ensure that it is dated and it pertains to the accounting period under consideration, and is duly checked and authorised for payment.

2. *Checking and ticking*. The calculations and the totals of each page and carry forward entries of each document of ledger are checked. Postings are also checked with subsidiary records, contra entries, and relevant correspondence. All checkings, whether of calculations or postings, are suitably check marked or ticked. This is done by ticking with coloured pencils or ink, by initialling, or by the use of an audit rubber stamp.

3. *Test checks*. If a reliable system of internal control procedure exists in the undertaking, the cost audit may be satisfied with test checks, there being no need to carry out a cent per cent check. The selection of items to be checked is made according to a predevised scheme. For cutting short the routine where numerous transactions are involved, statistical techniques may be employed. The various ratios may be ascertained and compared with suitable norms.

4. *Audit notes and questionnaire.* In course of audit, the auditor records on working papers the material facts observed by him. This also includes queries and questionnaires issued by him to the management for eliciting clarification and final answer. Some of the items which would appear in a questionnaire on labour and material are given below by way of illustration ; answer to each question is desired in the 'yes' or 'no' form.

Labour.

1. Are the attendance records of the workers completed on a day-to-day basis ?
2. Are gate passes made out for workers going out of the factory during working hours on duty or short leave ?
3. Is overtime work sanctioned by the appropriate authority only ? Are overtime notes prepared and recorded in attendance records ?
4. Are payments of wages made on due dates and in the presence of the representative of the Department or Shop concerned ?
5. Are payments to absent workers made only through the absentee payment register ?
6. Is reconciliation between gate time and job time made at regular intervals ?
7. Are the pay records of the workers showing the rates of pay and allowance, dates of increments, etc. kept up-to-date ?
8. Is leave to workers granted only by the proper authority, the period of leave granted posted immediately in the leave register, and the balance of leave due, struck ?

Material :

1. Are all materials purchased and received duly inspected for quality and noted in goods received notes ?
2. Are all goods returned properly accounted for ?
3. Are postings of receipts and issues made promptly and correctly in Bin cards ? Whether the balance is struck and noted after each entry ?
4. Are issues made only on the authority of materials requisitions ?
5. Are issue rates worked out correctly and on time ?
6. Is the valuation of materials requisitions and other similar documents correctly done ?
7. Are postings in stores ledger correctly made ? Whether balances are worked out after posting each transaction ?
8. Are postings of material costs correctly made in cost statements ?
9. Is stock verification carried out according to the plan ?
10. Is corrective action taken on discrepancies revealed in stock verification ?

5. *Audit report.* With the help of the working papers referred to above, an audit report is issued on completion of audit. The audit report is a very important document as it summarises the final result of the audit. It incorporates a certificate regarding the correctness or otherwise of the accounts and also, where required or called upon to do so, encloses reports on the operation and suggestions regarding improvements to be made and corrective measures to be taken. No standard form for an audit report can be laid down. In general, it should be seen that the report is concise and is rendered speedily so as to be of effective use to the management.

External or Statutory Cost Audit. Statutory cost audit may be necessitated in the following circumstances :—

- (i) *Price Fixation.* This would be necessary where the Government intends to fix the price of important commodities on a rational basis.

- (ii) *Tariff protection.* Cost audit is essential when the extent and nature of tariff protection to be given to particular industries are to be decided.
- (iii) *Cost-plus contracts.* Where contracts are placed on cost-plus basis, cost audit provides ready data, certified as to its accuracy, for the purpose of payment to the contractor company.
- (iv) *Mismanagement.* When there are reasons to doubt that prices are going up, profiteering is resorted to, or production is hampered due to mismanagement, or inefficient or fraudulent management, cost audit is of assistance in revealing the true state of affairs. This would protect the interests of the shareholders and of the public at large.

For special purposes, cost audit may also be desired by labour tribunals and trade associations.

Depending upon the purpose for which cost audit is ordered, the statutory cost auditor will be required to look into the following aspects :—

- (a) Verify whether the cost system has been laid down and implemented in a scientific manner.
- (b) Verify the cost statements prepared by the company after satisfying himself that the costs have been compiled on correct principles.
- (c) Ensure whether under- or over-absorption of costs has been properly explained and whether the extent of such under- or over-absorption is reasonable and bonafide.
- (d) Verify the correctness and bonafide of the values of closing stock and work-in-progress.
- (e) Satisfy himself that all costs have been properly included in the accounts and reconciliation between cost and financial accounts has been effected.

Under the provision of Sec. 209 of the Companies Act, 1956, as amended, the Government of India has taken powers to order companies engaged in production, processing, manufacturing or mining activities, to maintain in their books of accounts certain prescribed particulars relating to utilisation of material, labour and other items of cost. In exercise of these powers, the Government has from time to time, selected specified industries to be brought under the purview of these provisions of the Act and has framed Cost Accounting Records Rules for each such industry. So far, over two dozen industries have been brought under the ambit of these rules. The rules provide guide lines for the companies to maintain cost accounting records, the details of which vary according to the nature of the industry. Some of the main heads under which costs are generally required to be compiled are :

Production Materials : The records of receipts, issues and balances and the consumption of each item of material, including bought out components, are required to be maintained. The basis of calculation of the quantity and value of materials is to be indicated. The cost of any wastage of material in transit, during storage or for other reasons is to be worked out separately and the treatment of such losses in the accounts indicated. If the quantity and value of the materials consumed are determined on any basis other than actuals, the method of accounting is required to be indicated and the values of materials taken as consumed as per the estimates or standards are required to be reconciled periodically with the actuals. The treatment of variances is to be suitably indicated.

Consumable stores, small tools and machinery, spares etc. : The receipts, issues and balances and the consumption of each item are to be recorded in the same manner as for materials. Losses are to be similarly dealt with. Items which have not moved for more than 24 months are to be reported.

Power, fuel, steam etc. : Adequate records are to be maintained in order to ascertain the cost of power, fuel, steam etc. Where power or steam is purchased, the purchase cost is required to be shown separately. The allocation of power bills or generation cost to departments and products is also to be shown.

Wages and salaries : Records of attendance of the workers and other operational staff are to be maintained and the department in which each of them is employed is to be indicated. The system of remuneration and incentives paid, if any, are also to be indicated. The allocation of wages to departments, units and cost centres are to be shown. Idle time cost is to be calculated and recorded separately. If wages are charged on a basis other than actual, reconciliation is to be made and the treatment of variances of the actuals is to be suitably indicated.

Service department expenditure : The service department expenses are to be calculated separately and the allocation and/or apportionment of expenses to these departments are required to be shown.

Depreciation : The depreciation charged to cost should not be less than the amount worked out in accordance with sub-section (2) of Section 20 of the Companies Act, 1956. Suitable records of assets are also to be maintained.

Royalty and payment of technical aid : The record should indicate the basis of calculating and charging royalty and other allied payments to production cost.

Overheads : The works, administration, selling and distribution overheads are to be segregated. The methods of their calculation, allocation, apportionment and recovery in output are to be indicated. If the basis for charging overheads is other than actuals, the accounting of the variance is to be explained.

Work-in-progress : The value of work-in-progress should include materials, wages, overheads and depreciation. The records should also show the quantities of work-in-progress.

Reconciliation of cost and financial accounts : This is required to be done periodically.

Stock verification : Suitable records of physical stock verification are required to be maintained in respect of all materials including consumable stores, small tools and machinery, spares, work-in-progress and finished goods stock. Losses detected in course of such verification and their treatment in cost accounts are to be indicated.

The Cost Accounting Records Rules also prescribe the proformae of the various cost statements in which the cost of the products are required to be exhibited. The specimen of these forms may be seen in the Records Rules for the various industries. One such form prescribed for showing the cost of vanaspati is reproduced, by way of illustration, in Fig. 14.1.

The maintenance of cost accounting records in the manner stated above is a prelude to cost audit of the companies in the selected industries. Under Section 233-B of the Companies Act, the Government directs that the audit of cost accounts

of selected companies in different industries falling under the purview of the Record Rules be conducted by cost accountants. Thus, the statutory cost audit has so far been only selective and all companies and all industries are not covered. It is also not necessary, under the rules, that the cost audit of a company be conducted every year as a regular feature. The cost audit is in addition to the usual financial audit conducted by another auditor and the cost auditor has, in his sphere of work, the same powers and duties as the financial auditor, as stipulated in the relevant sections of the Companies Act, 1956.

The statutory cost auditor starts his work by studying :

- (i) The nature of the business and its organisation ; number of employees, licensed and installed capacities.
- (ii) The nature of production and the various manufacturing processes and operations involved and materials utilised in manufacture.
- (iii) The state of existing market for the products of the Company.
- (iv) The records and procedure in use, such as for accounting of materials, wastages, recording of wages, etc.
- (v) The principles of costing system adopted, e.g. method of overhead recovery, treatment of interest, depreciation, evaluation of work-in-progress etc.
- (vi) The nature and extent of the various internal checks and controls exercised.

The cost auditor then draws out an audit programme and proceeds to conduct the audit of the company's books and accounts, keeping in view the general principles and procedure of cost audit and the provisions made in this regard in the relevant Records Rules, as indicated in the preceding paragraphs. On completion of the cost audit of a concern, the auditor is required to render a report to the Government within a prescribed time limit. The procedure for framing the report and the details which it should contain have been prescribed in the Cost Audit (Report) Rules, 1968. Besides furnishing the various audit certificates and the cost statements in respect of completed products, as stipulated in these rules, the Cost Auditor is required mainly to furnish in the report, his notes, observations and comments on the cost accounting system, financial position, production data, raw materials consumption, power and fuel, wages and salaries, stores and spare parts, depreciation, sales, abnormal non-recurring costs etc. In addition, the cost auditor may also highlight other points of interest such as the factors responsible for the increase in costs of production, adequacy or otherwise of budgetary control system, suggestions for improvement in performance, etc.

The Cost Audit (Report) Rules and the various Cost Accounting Records Rules would indicate that the cost auditor is bound by the guidelines given in these rules and in course of audit, he primarily confines himself to the requirements of the rules. An internal cost auditor, on the other hand, would go much beyond the prescribed rules and the cost audit that he conducts would be guided by the requirements of the company and the services he is expected to render to the management as a cost auditor. This, however, does not mean that the work of the statutory cost auditor should be limited to routine checks only. The Cost Audit (Report) Rules give him ample scope to raise his work to the level of efficiency

NAME AND ADDRESS OF THE COMPANY.....

Statement showing the cost of naked Vanaspati/Refined Oil/Industrial Hard Oil/
Margarine during the year.....

		Current Year		Previous Year	
No. of days worked (for the manufacture of product concerned)					
Production Tonnes					
Particulars	Quantity Consumed units	Rate Per unit Rs.	Total Cost Rs.	Cost per tonne	
				Current Year Rs.	Previous Year Rs.
1	2	3	4	5	6
1. Materials :					
(i) Oils :					
(a) Ground Nut Oil : Produced/Purchased					
(b) Soyabean Oil					
(c) Cotton Seed Oil					
(d) Sesame Oil					
(e) Safflower Oil					
Total Oil					
Less Process Loss (Quantities only)					
(a) Ground Nut Oil					
(b) Soyabean Oil					
(c) Cotton Seed Oil					
(d) Sesame Oil					
(e) Safflower Oil					
Total					
Net Oil input					
Less : Credit for by-products (Realisable value)					
(a) Soap stock					
(b) Acid, trap oil, oil from sludge of storage tanks					
(c) Press cake					
Total					
Net Oil Cost					

Fig. 14.1. Cost Statement

Proforma B

Particulars	Quantity consumed units	Rate per unit Rs.	Total Cost Rs.	Cost per tonne	
				Current Year Rs.	Previous Year Rs.
1	2	3	4	5	6
(ii) Hydrogen (by weight)					
2. Chemicals					
(a) Bleaching Earth					
(b) Salt					
(c) Activated Carbon					
(d) Caustic Soda					
(e) Nickel Formate					
(f) Nickel Catalyst					
(g) Filter Cloth (Metres)					
(h) Sulphuric Acid					
(i) Citric/Tartaric Acid					
(j) Others					
Total Chemicals					
3. Vitamins					
4. Steam :					
(a) In neutraliser and other processes					
(b) Deodoriser					
5. Water					
6. Power					
7. Direct Wages					
8. Consumable stores, Small tools and machinery spares					
9. Repairs and Maintenance					
10. Depreciation					
11. Insurance (Factory)					
12. Administration Overheads					
13. Adjustment for difference in the values of opening & closing work-in-progress					
Cost of production of naked liquid Vanaspati/Refined Oil/Industrial Hard Oil/Margarine					

for Vanaspati

audit or management audit if he so likes, so that his audit report can be meaningful and of effective use in improving managerial efficiency of the company.

An extract from the Cost Audit (Report) Rules is reproduced below.

COST AUDIT (REPORT) RULES 1968

COST AUDIT REPORT

I/We*.....having been appointed as auditors(s) under Section 233B of the Companies Act, 1956 (1 of 1956) hereinafter referred to as the "Cost Auditor(s)" of Messrs..... Ltd. (hereinafter referred to as the company), have examined the books of accounts prescribed under clause (d) of sub-section (1) of section 209 of the said Act and other relevant records for the year ended.....relating to**.....maintained by the company and report that—

(a) I/We* have obtained all the information and explanations which to the best of my/our knowledge and belief were necessary for the purposes of this audit;

(b) proper cost accounting records as required under clause (d) of subsection (1) of Section 209 of the Companies Act, 1956 (1 of 1956) have been kept by the company ;

(c) proper returns adequate for the purpose of my/our *cost audit have been received from branches not visited by me/us*;

(d) The said books and records give the information required by the Companies act, 1956 (1 of 1956) in the manner so required; and

(e) in my/our* opinion the company's cost accounting records have been properly kept so as to give a true and fair view of the cost of production, processing, manufacturing or mining activities, as the case may be, and marketing of the product under reference

The matters contained in the Annexure to this report form part of this report also subject to my/our* observations made therein.

Dated this.....day of..... 19 .. at @
Cost Auditor(s)

ANNEXURE TO THE COST AUDIT REPORT

1. General

- (1) Name and address of the registered office of the company whose accounts are audited
- (2) Name and address of the Cost Auditor.
- (3) Reference No. and date of Government Order under which the audit is conducted
- (4) Reference numbers and date of the Government letter approving the appointment of the cost auditor.
- (5) The company's financial year for which the audit report is rendered
- (6) Date of incorporation of the company, and its 'status' (i.e. whether it is a public company/private company/private company which is a subsidiary of a public company etc.)
- (7) Location where accounts are maintained.
- (8) Location of Factory/Factories.
- (9) If there is any foreign technical collaboration for the product under reference, attach a copy of the collaboration agreement. If this is not possible, prepare a brief note indicating—
 - (a) Name and address of the foreign collaborator.
 - (b) Main terms of agreement.
 - (c) Amount of Royalty/Technical aid fee payable and the basis of calculating the same.
 - (d) Whether, the technical collaboration has contributed to the share capital. If so, the paid-up values of shares so held.

*Delete inapplicable words.

**Here specify the product under reference.

@Mention place

- (10) Date of first commencement of commercial production of the product under reference. (If more than one factory under the same company produces the product under reference, particulars in respect of each may be given).
- (11) If the company is engaged in other activities besides the manufacture of the product under reference, give a brief note on the nature of such other activities.
- (12) Whether the company is registered or has applied for registration under the Monopolies and Restrictive Trade Practices Act, 1969 (54 of 1969) and/or governed by the Foreign Exchange Regulations Act, 1973 (46 of 1973).

2. Cost Accounting System

Briefly describe the Cost Accounting System existing in the company and comment on the same, keeping in view the requirements of the Cost Accounting (Records) Rules applicable to the class of companies manufacturing the product under reference and also its adequacy or otherwise to determine correctly the cost of production of the product. The description of the system shall cover, inter-alia, the procedure for accounting of materials, labour, depreciation, overheads and their allocation/apportionment and absorption to products, treatment of by-products, joint products, scrap etc. Specify persistent deficiencies in the system (pointed out in the earlier reports) but not rectified.

*3. Financial Position

(Indicate the particulars of the amounts included in terms of (1) (a), (2) and (3) (a) below duly reconciled with the financial accounts of the company for the relevant period).

(1) Capital employed

Capital employed—defined as total assets at net book values (excluding investments outside the business, capital work in progress, miscellaneous expenditure and losses) minus current liabilities :—

- (a) for the company as a whole,
- (b) for the product under reference.

Note : Interest bearing loans shall not be included in current liabilities.

(2) Net Worth

Net worth, i.e., share capital plus reserves and surplus less accumulated losses and intangible assets. If there is any change in the composition of the net worth during the year, special mention may be made along with the reasons therefor.

(3) Profit before tax

Profit after providing for depreciation and all other expenditure except interest on borrowings and debentures but before providing for taxes on income

- (a) for the company as a whole,
- (b) for the product under reference.

(4) Income to be specified

- (a) Interest received on investments outside the business.
- (b) Capital gains.
- (c) Any other income which is neither normal nor of a recurring nature.

(5) Ratios

- (a) Profit arrived at as per 3(3)(a) and 3(1)(b) above expressed as a percentage of :—

- (i) capital employed as per 3(1) (a) and 3(1) (b) respectively.
- (ii) net sales for the company as a whole and for the product under reference, respectively.

- (b) (i) Current assets expressed as a percentage of current liabilities.
- (ii) Net worth expressed as a percentage of long term borrowings and liabilities (excluding current liabilities).

- (iii) Net worth expressed as a percentage of capital employed as per 3(1)(a) above.

- (c) (i) Cost of sales of the product under reference as a percentage of :
Capital employed as per 3(1)(b) above.

- (ii) Cost of sales excluding depreciation of the product under reference, as a percentage of working capital (i.e. current assets less current liabilities), for the product under reference.

Note : Amount of net fixed assets, working capital and net worth shall be indicated as on the last day of the year.

***4. Production**

(The following information is to be given for each type of product under reference and for each factory).

- (1) Licensed Capacity (Give reference to license number etc.)
- (2) Installed Capacity.
- (3) Actual production.
- (4) Percentage of production of the product under reference in relation to installed capacity.

Notes : (1) In order to have a meaningful comparison of production and installed capacity wherever necessary, these should also be expressed in appropriate units, e.g. standard hours or equipment/plant/vessel occupancy hours, crushing hours, spindle/loom shifts etc. If there is any shortfall in production, as compared to the installed capacity, brief comments should be furnished as to the reasons or the shortfall bringing out clearly the extent to which they are controllable both in short term as well as long term.

(2) It should be clarified whether the installed capacity is on single shift or multiple shift basis.

5. Process of Manufacture

A brief note regarding the process of manufacture of the product under reference may be given.

6. Raw Materials

- (1) Show the cost of major raw materials consumed both in terms of quantity and value. Where the cost of transport etc. of raw materials is significant, specify separately. In the case of major imported raw materials, FOB value, ocean freight, insurance, customs duty and inland freight charges may be indicated. If both indigenous and imported materials are consumed, the percentage mix of the same may be indicated for each item.
- (2) (a) Quantity of consumption of major raw materials per unit of production.
(b) Standard requirements/theoretical norm per unit of production in terms of quantity.
(c) Explanations for variations, if any, in the quantity of consumption of major raw materials per unit of production as compared to standard consumption/theoretical requirement, and also of the consumption of the preceding two years
(d) Indicate the value of raw materials and components, finished and semi-finished which have not moved for one year and above and indicate their proportion to the value of stock at the end of the year.

***7. Power and Fuel**

Quantity, rate per unit and total cost for each major form of power and fuel used in production, e.g. coal, furnace oil, electricity and other utilities separately. Compare the actual physical consumption per unit of production with standards or theoretical norms, if any, and the with the preceding two years' consumption. Special features, if any, may also be indicated. In case power is generated by the company, a comparison of the cost per unit generated with that purchased may be indicated for three years.

***8. Wages and Salaries**

- (1) Total wages and salaries paid for all categories of employees, separately in respect of each of the following :—
 - (a) Direct labour costs on production.
 - (b) Indirect employee costs on production.
 - (c) Employee costs on administration.
 - (d) Employee costs on selling and distribution.
 - (e) Other employee costs, if any (specifying purpose).
 - (f) Total employee costs (total of items (a) to (e) above).
- (2) Total man-days of direct labour available and actually worked for the year.
- (3) Average number of workers employed for the year.

- (4) Direct Labour cost per unit of output of the product under reference (if more than one type of product, give information in respect of each).
- (5) Brief explanations for variations in (4) above, if any, as compared to the previous two years.
- (6) Comments on the incentive schemes, if any, with particular reference to its contributions towards increasing productivity and its effect on the cost of production.

9. Stores and Spare Parts

- (1) The expenditure per unit of output on stores etc.
- (2) Indicate, the amount and also the proportion of closing inventory of stores representing items which have not moved for over 24 months.

10. Depreciation

- (1) State the method of depreciation adopted by the company, e.g. straight line or diminishing balance etc. State whether the depreciation provided by the company is more or less than the amount of depreciation worked out in accordance with provisions of sub-section (2) of Section 205 of the Companies Act, 1956. In the case of assets or group of assets on which depreciation is written off at the rate of 100 per cent in the relevant year, and the benefits from such assets is likely to be derived over a period beyond the relevant year, the depreciation should be rationally spread over the economic life of the assets. The impact of charging additional depreciation at the rate of 100 per cent in the relevant year vis-a-vis the depreciation chargeable on the basis of economic life of the assets shall be indicated in total as well as for the product manufactured.
- (2) State the basis of allocation of depreciation of common assets to the different departments.

11. Overheads

- (1) Give separately the total amount of the following overheads for the company/factory as a whole : -
 - (a) Factory overheads.
 - (b) Administrative overheads.
 - (c) Selling and distribution overheads.
 - (d) Annual bonus to employees (the amount of minimum bonus under the Payment of Bonus Act to be furnished separately).
 - (e) Interest on borrowings including debentures.
 - (f) Bad debts.
 - (g) Donations of all kinds.
 - (h) Retrenchment or other compensation to employees excluding premia on account of workmen's compensation insurance.
 - (i) Lay off wages.
 - (j) Expenditure on special exhibitions etc. other than normal trade advertisements.
 - (k) Commission based on profit to Management Personnel.
 - (l) Any other item of expenditure the incidence of which is neither normal or of a recurring nature.
 - (m) Prior-period charges.
 - (n) Other expenses or portions thereof, which are not admissible under Income Tax Act, like
 - (i) Perquisites of executives.
 - (ii) Guest House expenses.
 - (iii) Advertisement expenses.
 - (iv) Ex-gratia payments to staff.
 - (v) Donations and Charities.
 - (vi) Loss on exchange.
 - (vii) Others to be specified.

In respect of items (a), (b) and (c) above, give the amounts relating to the products under reference along with the break up and state whether any amounts in respect of (d) and (n) above have been included in the total amounts of items (a), (b) and (c) relating to the products and the extent to which included.

Note : Indicate reasons for any significant variations in the expenditure incurred against the items of overheads, viz. (a), (b) and (c) as compared with the previous two years, particularly for the product under reference.

***12. Royalty/Technical Aid Payments**

State the total amount Royalty/Technical Aid Fees payable for the year and the amount chargeable per unit of the product.

***13. Sales**

- (1) Indicate the sales in quantities and net sales realisation of the products under reference showing the average sales realisation per unit. (If more than one type of product is sold, information to be given in respect of each).
- (2) If the product under reference is exported, indicate quantity exported, net realisation per unit, countries to which exported—details may be given. Indicate the profit/loss incurred in exports.
- (3) Any packing charges not included in the price charged to the customers may be indicated with the incidence of cost and amount recovered from the customer.
- (4) The actual incidence of delivery and freight charges incurred for the quantity sold and the freight recovered from the customers directly and/or from the freight pool may be indicated separately.
- (5) Where the products are sold at different prices in accordance with Government policy as in the case of sugar, cement etc., sales realisation at different prices shall be shown separately along with quantity and value.

14. Abnormal Non-Recurring Costs

If there were any abnormal features affecting production during the year—~~e~~ lockouts, major breakdowns in the plant, substantial power cuts, serious accidents etc. they shall, wherever practicable, be briefly mentioned indicating their effect on unit cost of production.

15. Other Items

If there are any special expenses which have been directly allocated to products under reference the total amount as also the unit incidence shall be shown.

16. Auditors' Observations and Conclusion

- (i) The cost auditor may here report on—
 - (a) matters which appear to him to be clearly wrong in principle or apparently unjustifiable ;
 - (b) cases where the company's funds have been used in a negligent or inefficient manner ;
 - (c) factors which could have been controlled, but have not been done resulting in increase in the cost of production ;
 - (d) contracts or agreements, if any, between the company and other parties relating to selling, purchasing bringing out any peculiar features, undue benefits etc.
 - (e) (i) the adequacy or otherwise of budgetary control system, if any, in vogue in the company ;
 - (ii) the scope and performance of internal audit, if any, and its adequacy or otherwise.
- (f) suggestions for improvements in performance, if any, e.g., by—
 - (1) rectification of general imbalance in production facilities ;
 - (2) fuller utilisation of installed capacity ;
 - (3) concentration on areas offering scope for—
 - (i) cost reduction
 - (ii) increased productivity
 - (iii) key limiting factors causing production 'bottlenecks'.
 - (4) improved inventory policies.

The opinions expressed shall be based on verified data, reference to which shall be made here and shall wherever practicable, be included after the company has been afforded an opportunity to comment on them.

- (ii) Copies of all cost and other statements in respect of intermediate and completed products as prescribed in Schedule II of the relevant notification issued under clause (d) of sub-section (1) of Section 209 of the Companies Act, 1956 duly completed and audited shall be appended to the report.

However, the Company Law Board may at its discretion order the discontinuation or modification either permanently or temporarily of the submission of the detailed cost statements in respect of the whole or a part of the items referred to in this para.

- (iii) If as a result of the examination of the books of account, the auditor desires to give a qualified report, he shall indicate the extent to which he has to qualify the report and the reasons therefor.
- (iv) A statement showing the reconciliation of the profit or loss as indicated under 3(3)(a) above with the profit or loss relating to the product under reference as arrived at on the basis of the cost statements annexed to the report and the net sales realisation as indicated in 13(1) above shall be appended to the report.
- (v) After the auditor appointed under Section 224 of the Companies Act, 1956 (1 of 1956) submits his report, the cost auditor may, if he considers it necessary, submit a supplementary report to the Company Law Board before the date fixed for holding the annual general meeting of the Company. The supplementary report shall be limited to the extent of reconciling the statements annexed to the cost audit report with the financial accounts of the Company.

- Note :*
- (1) *Figures to be given for the year under audit for the two preceding years in respect of paras 3, 4, 6, 7, 8, 9, 11, 12 and 13.
 - (2) If the Company has more than one factory producing the product under reference, details indicated in the annexure may be given separately for each factory, if such details are available.
 - (3) If different varieties/types of products under reference are manufactured by the company, details of cost in respect of each shall be given.
 - (4) The matters contained in the annexure shall be duly authenticated by the cost auditor by initialling each page thereof.
 - (5) The report should be neatly stitched and bound in a file and should be sent by Registered post/acknowledgement due, or otherwise delivered in person through messenger and acknowledgement obtained.

MANAGEMENT AUDIT

Management audit is the appraisal of managerial performance. It goes through the entire process covered by the Management Accountant. The function of the Management Accountant is to present information in such a way as to assist management in the formulation of policy and in the day-to-day working of business. For this purpose, the Management Accountant is associated right from the initial stages of conception and planning to the operative or executive and marketing stages of the business. Management audit ensures that at every stage of planning and operation, the accounting records, procedure, and information are not only in accordance with the correct principles laid down but they also state the facts and trends correctly and faithfully. In short, management audit watches whether or not the affairs of management are conducted efficiently; it covers primarily, the fields of efficiency and performance audit and secondly, propriety audit.

The scope of management audit has not yet been standardised and opinions in this regard vary. One view is that it tests, (i) adherence to internal policies and procedures such as operating controls and procedures, relations with customers, employees etc. (ii) results like profit capabilities and (iii) external aspects such as relations with trade, public and environment outside. Another school of opinion considers management audit as executive audit rather than policy audit. In other words, management audit appraises methods and procedure but not the policy decisions taken by the management.

Starting from the placing of indent of materials up to the collection of sales revenue from the customer, management audit is associated closely with the management to a degree which statutory or professional audit cannot be expected to do. While statutory audit is satisfied with a check of the figures leading up to the preparation of the profit and loss account and the balance sheet, management audit ensures the efficiency of all the areas covered by the management. Statutory audit protects the interest of the shareholders whereas management audit looks towards the interest of the management. Statutory audit looks to the past only ; it does not extend to future assessments and planning as the management audit is required to do.

A brief synopsis of the various areas covered by management audit is given below :

1. *Marketing function*

- (a) Market survey, sales forecast, and sales and distribution policy.
- (b) Sales planning based on market research or survey, keeping in view production policy and capacity.
- (c) Policy for sales promotion or advertising.
- (d) Product pricing policy ; discount and credit policy.
- (e) Organisation of various channels of sales and distribution.

2. *Production management*

- (a) Production planning and its co-ordination with production.
- (b) Utilisation of capacity ; best use for idle or surplus capacity.
- (c) Production performance evaluation ; deviations from norm or standard plan.
- (d) Organisation for tools, maintenance, and repairs.
- (e) Specifications and standards for materials and operative time ; machine as well as manual. Improvement of production methods and development, designing, and testing of new products and production methods.
- (f) Research.
- (g) Value analysis.
- (h) Job evaluation.
- (i) Cost reduction.

3. *Inventory control*

- (a) Purchase organisation and procedure ; operating of provisioning drill, e.g. determination of order levels, safety balance, and optimum order size.
- (b) Storage procedure ; cost of inventory carrying and inventory shortage.
- (c) Issue routine.
- (d) Slow moving and obsolete items ; inventory turnover.
- (e) Valuation of stock and work-in-progress.

4. *Personnel administration*

- (a) Procedure for recruitment, promotion, transfer, and training time and costs— personnel shortages, oversupplies, layoffs, overtime etc.
- (b) Absenteeism and sickness, recruitment times and costs, action taken to reduce them.
- (c) Methods for wage payment and incentives, wage and salary administration.
- (d) Labour turnover ; methods adopted to analyse and action taken to reduce high rate of labour turnover.
- (e) Accidents ; preventive measures for safety.
- (f) Welfare measures.
- (g) Productivity of labour, performance norms.
- (h) Discipline and morale, union-management co-operation, collective bargaining, participative involvement etc.

5. *Financial control*

- (a) Setting and operation of budgetary system of control ; report of variances.
- (b) Internal audit including cost audit.
- (c) Financial reports and financial ratios ; rendering analysis of interpretation.
- (d) Scrutiny of financial proposals ; investment plans and project decisions.
- (e) Delegation of financial powers.

6. *General*

Organisation for,

- (i) delegation of authority,
- (ii) flow of information, and
- (iii) levels of decision making.

EXAMINATION QUESTION

1. It has been stated that "the important aspects of Cost Audit are (a) propriety audit and (b) efficiency audit." Elaborate on this statement. *(I.C.W.A., Final)*
2. "The object of the amendment of sub-section (1) of Section 209 of the Companies Act is to ensure that in respect of companies engaged in production, processing, manufacturing or mining activities which may be specified by notification issued by the central government, proper records relating to utilisation of material and labour are available which would make the efficiency audit possible."
Explain what is meant by Efficiency Audit and illustrate with reference to the cost of spare parts and stores to be audited under the Cost Audit (Report) Rules, 1968. *(I.C.W.A., Final)*
3. Outline the scope of internal audit in an organisation with manufacturing (having two separate plants), administrative and marketing divisions.
Indicate with reasons, the importance of cost audit. *(I.C.W.A., Final)*
4. State briefly the areas of control which in your opinion, should be covered by a scheme of internal audit for a large undertaking. What is the relationship between internal audit and statutory audit? *(I.C.W.A., Final)*
5. (a) What is 'Internal check' ? What are the essentials of such a system ?
(b) Is it synonymous with 'Internal control' ? *(I.C.W.A., Final)*
6. Discuss the functions of 'cost audit' in a manufacturing organisation. *(I.C.W.A., Final)*
7. Cost audit will help to maintain, among other things, the integrity of inventory valuation. Discuss the role of cost audit in this as well as in other fields. *(I.C.W.A., Final)*
8. As a part of cost audit, you are making a test check of the routine followed, from the raising of a purchase requisition by the stores department to the entries covering the receipt of the goods in the stores and cost ledgers.
Enumerate the documents and entries you would inspect, giving brief details of the main points you would check. *(I.C.W.A., Final)*
9. Enumerate at least twelve points which you would look into in conducting a cost audit programme of material, labour and overhead. Write a report to the management on any two of these points. *(I.C.M.A., Inter)*
10. Draft a brief report to the Managing Director on the desirability of introducing the system of pre-audit of purchase orders and contracts, pointing out defects in the existing system of post-audit and stressing the important aspects of pre-audit examination. *(I.C.W.A., Final)*
11. State the essential features of cost audit. In what respects is cost audit different from financial audit ? *(I.C.W.A., Final)*
12. A system of Internal Audit has just been installed in a manufacturing concern which employs about 2,500 workers and handles a large number of items of raw materials. Set out the main points to which attention should be paid by the Internal Auditor to ensure an efficient control of stores and labour in the concern. *(I.C.W.A., Final)*

13. Give an analysis of the functions of Cost Audit in respect of Inventory, Work-in-progress and Overheads. *(I.C.W.A., Inter)*
14. The cost audit report rules require that the cost auditor should report on the scope and performance of the Internal audit, if any, in a company which he cost audits. For the purpose, your cost auditor requests you, the Chief Internal Auditor of a company, for a short note. He further suggests that since in your company materials constitute the major element of cost, your note should illustrate, the objectives and performance of internal audit, from any aspect of 'material audit' covered by you. *(I.C.W.A., Final)*
15. What do you understand by the term 'Verification of Assets'. Prepare an audit programme for verification of finished goods of a factory, assuming that you are the external auditor of that company. *(I.C.W.A., Final)*
16. (a) In what way Cost Audit is different from Statutory Audit ?
(b) What are the areas of activity which a Cost Audit Programme is expected to cover ? *(I.C.W.A., Inter)*
17. As Management Auditor of a Company, which is capital intensive, enumerate the procedures which you would consider adequate for internal control over property, plant and equipment. *(I.C.W.A., Final)*
18. In which directions are the costing records of value to the auditors of the financial accounts ? To what extent do you consider an independent audit of the cost accounts is necessary ? *(I.C.W.A., Final)*
19. "Cost Audit" is a necessity and not a luxury and is viewed as a barometer to measure the operational performance, the effectiveness of utilisation and working results. Illustrate. *(I.C.W.A., Final)*
20. Government of India has made Cost Audit obligatory in cases of industries considered necessary by it through an amendment of the Companies Act. Enumerate the purpose of this Cost Audit and indicate how ultimately it will benefit the producer, consumer, the State and the shareholders. *(I.C.W.A., Final)*
21. What, in your opinion, are the cardinal differences between the report of the Statutory financial Auditor of a company under Section 227 of the Companies Act and the cost audit report of the Cost Auditor under the Cost Audit (Report) Rules, 1968 ? *(I.C.W.A., Final)*
22. Cost Audit is more an aid to management than a statutory check on its performance. Do you agree with this statement ? Give reasons for your answer. *(I.C.W.A., Final)*
23. The company in which you are employed, manufactures a product, for which recently Cost Accounting Records Rules have been prescribed. The Managing Director desires from you a note on cost audit, for future reference. Prepare such a note mainly highlighting the procedural aspects from point of receipt of an order for cost audit till the submission of the report. *(I.C.W.A., Final)*
24. The cost audit report rules require in Para 9 of the Annexure to the cost audit report comments from the Cost Auditor on 'Stores and Spares'.
Prepare such comments, assuming that you have been appointed as Cost Auditor of a company, for a product, familiar to you. *(I.C.W.A., Final)*
25. What do you understand by the term 'Management Audit'? Discuss in brief the scope of such an audit and the benefits which the management can derive therefrom. *(I.C.W.A., Final)*
26. An organisation exists with well-defined jurisdictional activity under the following :

Production	Research and Development
Distribution and Sales	Legal and Secretarial
Finance and Costs	Personnel and Public relations

As a Management Auditor broadly indicate the areas and scope of the audit and the information you would be reporting to the Managing Director. *(I.C.W.A., Final)*
27. Carefully examine the concept, scope and objectives of Management Audit in the context of present-day industrial development in this country. *(I.C.W.A., Final)*
28. Under Item 3—Annexure to the Cost Audit (Report Rules), 1968 as amended, financial position of the Company under audit is required to be stated.

You are the cost Auditor of X Y Z Ltd.

- (a) From the following Profit & Loss A/c. and Balance Sheet, calculate the various ratios required under the above rules.
 (b) State also the various items of Expenses and Incomes to be specified as per the above audit report Rules.

Profit & Loss A/c for the year ended 31st December 19....

Particulars		Rs.
Net Sales		3,00,000
Less Cost of Production		2,58,000
		<hr/>
		42,000
Operating Expenses	Rs.	
Selling	2,200	
General Administration	4,000	
Rent of Office	2,800	9,000
	<hr/>	<hr/>
Gross operating profit		33,000
Depreciation		10,000
		<hr/>
Net operating profit		23,000
Other Income (Interest on Govt. Securities)		1,500
		<hr/>
Gross Income (Before Tax)		24,500
Other Expenses	Rs.	
Interest on Bank overdraft	300	
Interest on Debentures	4,200	4,500
	<hr/>	<hr/>
Net Income before Tax		20,000
Tax 50% on Net Income		10,000
		<hr/>
Net Income after Tax		10,000

Balance Sheet as on 31.12.19....

Liabilities	Rs.	Rs.	Assets	Rs.	Rs.
Equity Share Capital		50,000	Fixed Assets	1,80,000	
			Less : Depreciation	50,000	1,30,000
				<hr/>	
7% Pref. Share Capital		10,000	Investment in Govt. Securities		15,000
Reserve & Surplus		40,000			
6% Mortgage Debentures		70,000			
Current Liabilities			Current Assets		
Sundry Creditors	6,000		Sundry Debtors	20,000	
Bills payable	10,000		Stock	30,000	
Outstanding Expenses	1,000		Cash	5,000	55,000
				<hr/>	
Provision for taxation	13,000	30,000			
		<hr/>			<hr/>
Total		2,00,000			2,00,000
		<hr/>			<hr/>

(I C W A , Final)

CHAPTER 15

INFORMATION SYSTEM, DATA PROCESSING AND COMPUTERS

In order to assist the management in taking appropriate action, information is communicated in the form of reports, statements, charts, and graphs. The information communicated covers physical facts as well as cost data. In small organisations where the top level management is in close contact with almost all the departments and thus has an intimate knowledge of the various activities of the business, the necessity for presentation of information may not be keenly felt. In big organisations where the top man has little time or less opportunity to come in contact with the lower levels of management, the position is different and communication of information assumes considerable importance.

An important function of the cost accountant is to evolve a suitable system of reporting cost and financial information relating to the various activities in a quick, correct, and efficient manner. Reports are aimed at or directed to specific individuals or group of individuals at various levels of management, and they contain information in respect of individual sectors of action and responsibility. Good reports show favourable and unfavourable past actions, present situation, and future trends. With the facts and information presented in the reports, the management is able to evaluate performance, i.e. assess the results of the plan of action of the company, effect necessary changes or take other action as necessary, and plan for the future.

It would rather be impossible to list out the reports, statements, etc. that would be suitable for all organisations. The requirements of an individual business should be studied and the reporting system should be fitted in accordance with its needs. The information to be submitted would need frequent review and adjustments to the changing requirements of the management. Thus it is left to the ingenuity and skill of the reporting individual to present information in the best possible manner. The purpose of this chapter is to discuss in general, the principles involved in the preparation and presentation of information.

Information for Various Levels of Management. The fundamental rule for a system of reporting is that the information submitted should be in accordance with and appropriate to the requirement of the recipient, firstly, with regard to his level or status and secondly, his knowledge and responsibility. Reports are prepared for each executive from the bottom to the highest level of management. For a reporting system to be effective, the various levels of management and their diverse responsibilities for operating and for decision making should be recognised and the system designed accordingly.

In general, information may be communicated to three levels, namely :

(i) *Operating and direct supervision level* : This level of management is immediately responsible for the day-to-day operation of the various sectors of the business and usually this level would not be concerned with decision making

activities. Detailed and specific reports restricted to the activity with which the chargemen, foremen, and the supervisors (i.e. those immediately responsible to look after the operators' work) are concerned are required for this level. The planned and actual performances and variations from the plan should be reported, both in physical and monetary terms.

(ii) *Middle or co-ordinating level* : This level is comprised of the heads of the departments such as the production manager, works engineer, purchase executive, sales manager, chief inspector, and chief accountant, who supervise the execution by the operating level of the plan set by the top management. Normally, this level is responsible for the work of a group of section supervisors. Often, this level would be required to take short-term tactical decisions such as those relating to recruitment and training of personnel, product design, product-mix, budgeting, marketing, manufacturing control, etc. The reports for this level will show in aggregate, the results of the operating level but these should be slightly more broad-based and should contain less details than those in the reports meant for the lower level. The reports should show the efficiency and cost data for a group or a department.

(iii) *Top level or general management* : This level is comprised of top persons in the hierarchy such as the proprietors, chairman or president, vice-president, board of directors, managing director, and chief executive, who are occupied with matters of policy and higher administration and have little time to go through details of relatively less importance. It is this level which makes long range policy or strategic decisions relating to the objectives of the concern. Operational information for this level should, therefore, highlight departmental efficiency and inefficiency and the comparative results from one period to another. An analysis of the causes for inefficiency should also be given. The information supplied to the top level is mainly profit motivated that should reveal the trend rather than show the details and it should stress commercial and financial aspects bringing out all the activities having a financial bearing. Report for this level or for that matter, for any level of management, should follow the principle of 'reporting by exception'. Only those facts which deviate from the standard or target, should be brought out leaving out the mass of normal or routine items to take care of themselves. Instead of details, only summarised totals or summaries of important points may be given so that the management can scan through them quickly and take corrective action or decide policies.

Objectives of a System for Communicating Information. It is difficult to imagine a business running without an efficient system of reporting. Even in the smallest of concerns, unless the operatives render information to the supervisor (though it may be only oral) and unless the supervisor in turn communicates with the boss, the business would come to a standstill. The objectives of submitting information are varied. Some of these are as follows :—

- (i) A system of reporting is essential for efficient and effective planning and control.
- (ii) The results of measurement and analysis of performances of men, materials, plant and machinery, and other resources are brought to light. Reports tell how effectively the various production, marketing and finance factors have been utilised. Efficiency of individuals and

departments like purchase, sales, production, and engineering may be watched through the information supplied, and responsibilities can be fixed.

- (iii) Reports reveal by comparison, causes of variations from norms, standards, or budgets and point out unfavourable conditions so that proper remedial measures may be taken.
- (iv) Hidden costs like costs of idle time, high labour turnover, and surplus capacity are revealed.
- (v) Reports assist in controlling cost by pointing out wastage and losses.
- (vi) Reports are useful for schemes of reduction of costs.
- (vii) Data collected at the operational level are carefully processed into information reports which are valuable aids to policy and decision making. The anticipated effects of proposed decisions for alteration and expansion of the existing operation are disclosed.
- (viii) Reports on production statistics regarding rejection, spoilage, etc., and their effect on costs are of assistance in quality control.
- (ix) Adverse and favourable trends, within and outside the organisation, are brought out so that action to improve the situation or to take advantage of the opportunity available, as the case may be, may be taken.

Requisites of an Effective Information System. These are :

(a) *Timing of presentation* : Promptness in preparation and rendering of reports is of paramount importance. If there is considerable time lag between occurrence and reporting, the information communicated may be received too late for any action. Opportunity may be lost or wrong decision may be taken in absence of information that is rendered after such a decision has been taken. The periodicity of a report should be kept in view and different types of reports submitted at suitable intervals, depending upon the nature of the information conveyed and the needs of the management. While speedy reports are desirable, too frequent reports lose their effectiveness. Reports at quick intervals become repetitive and are likely to be taken as a matter of routine ; they are costly and involve waste of time on the part of the recipient.

The availability of high speed data processing contrivances and techniques in modern times has practically eliminated the time factor and information can be supplied now with amazing promptness. Even where sophisticated aids are not available, the following techniques may be adopted for speeding up the rendition of reports :—

- (i) Accumulation of most of the figures sufficiently earlier than the actual date of rendition of the report so that minimum work is involved at the last moment.
- (ii) Closing accounts earlier than scheduled dates.
- (iii) Use of pre-closing, interim, or flash reports based on carefully prepared estimated data.
- (iv) Review of the system so as to eliminate bottlenecks in scheduling and standardisation and simplification of forms and records.
- (v) Use of standard costs.

(b) *Accuracy* : Data collected should be correct and their arithmetical accuracy should be checked. Mechanised and other modern data processing systems are very useful for ensuring the accuracy of the reports and statements rendered. It is needless to emphasise that wrong information given to the management may result in wrong decisions.

Accuracy should not be achieved by sacrificing promptitude. It is better to have approximate but timely reports than to have very accurate but late reports. Ensuring accuracy costs money and time. The degree of accuracy desired for a particular report should, therefore, depend upon the cost of compiling the report.

(c) *Cost of reporting* : The cost of rendering information should be compared with the value of the advantage gained from the report or the loss sustained by not reporting. As it is difficult to assess these factors monetarily, it is left to the judgement of the accountant to render information in the most economical way.

(d) *Form of the report* : The style and layout of a report will depend upon the needs of the individual to whom it is rendered. Reports may be rendered orally in course of conversation, meeting, and conferences, or in the form of graphs, charts, statistical tabulations, or narration. These will be discussed later.

(e) *Contents of a report* : No rule in this regard can be laid down as the contents of a report will depend upon a very large number of factors. The following general principles should, however, be taken into consideration :—

- (i) Each report should have a self-explanatory title and should state the period to which it relates. The language of the report should be clear and charts and diagrams should be visually attractive. Accounting jargon which the recipient may not properly understand and should be avoided.
- (ii) The contents should be brief and precise. Unimportant data should be removed and only relevant information included in the report. Going through a mass of unnecessary details is time consuming, and in the process, some important points are likely to be overlooked. Bulky statistical details, if absolutely necessary, may be included in appendices and schedules attached to the main report. At the same time, a report should not be so brief as to lose its informative value.
- (iii) The data furnished should have suitable units of measurement such as values, percentages, ratios, index numbers, statistical measures, and rates.
- (iv) Each information given should have a purpose and meaning, and repetition should be avoided.
- (v) There should be uniformity in presentation and the source from which information is collected should be properly defined. The form should not be changed too frequently.
- (vi) Controllable factors should be distinguished from non-controllable factors and reported separately.
- (vii) Suitable yardsticks, norms, or comparative figures should be given to enable control being exercised. The two sets of figures, viz. the actual and the yardsticks should be prepared on the same basis. Differences or variations should be properly highlighted. For example, actuals may be compared with budgets, standards, or past actuals ; the

performance of one department may be compared with that of another ; and one factor may be compared with another, e.g. selling expenses with sales, cost with sales price, etc.

- (viii) Appropriate comments should be given in the report. Correct interpretation should be made and adequate data given to suggest possible course of action. Managers and technicians, not being accountants, appreciate this assistance and it saves time and ensures prompt attention.

(f) *Periodical review* : The form and contents of a report should not be of a permanent nature, valid for a very long range and period of time. Routine reporting develops staleness and after some time, such reports are simply filed away as the recipients consider them to be useless. Another drawback is that in the maze of data and reports which go on piling up in course of time, significant facts are overlooked. Periodical review of all reports and statements should be made to determine their necessity or redundancy and the need for their revision or betterment. One method of review is to issue a questionnaire asking the recipients to comment on the utility of the report supplied to them.

Special Reports. Reports may be rendered at periodic intervals as a matter of routine or on particular occasions when called for. Problems which very often arise in a business are required to be investigated. The results of the investigations and the recommendations are incorporated in special reports. The form of a special report and the matter covered in it will vary according to the nature of the problem investigated. A special report usually contains the terms of reference, i.e. the problem to be studied, the investigations carried out, the findings, and the suggestions and recommendations made.

Some of the problems on which special reports may be rendered are given below :—

1. *Production delays and bottlenecks.* Reasons for the delays and bottlenecks together with their effect on cost will be given. Recommendation for removal of the impediments should also be given.
2. *Under-utilization of plant capacity or idle capacity.* The effect of surplus or idle facilities on costs of different products should be furnished.
3. *Capital investment problems.*
4. *Make-or-buy problems.*
5. *Labour turnover.* Analysis of high labour turnover, its causes, effect on costs, and preventive and corrective actions taken should be furnished in the report.
6. *Inventory reports.* Reports on inventory shortage, excessive stock, and slow-moving and non-moving stock may be required.
7. *Price fixation problems.* In normal times and in times of recession, special reports to guide pricing policies may be furnished.
8. *Research and development.* The report should indicate the objectives, the results achieved, and the cost incurred.
9. *Working capital.* Shortage or excess of working capital, assessment of its requirements, and suggestions for obtaining funds or disposal of funds.
10. *Investment policy.* The best manner in which to invest surplus funds, and a comparative study of the various channels available.
11. *Raising funds.* How and in what form long-term capital such as share capital, debentures, loan, etc. should be obtained.

12. *Feasibility study for a project or for installing a computer.*
13. *Diversification of production.* The effect of diversification on production facilities, costs, and profits.
14. *Changes in methods of production, design, and system.* When alternatives are available, suggestions for a particular line of action should be made, based on the various factors such as costs, profit, availability of resources, capital investment, and market conditions.
15. *Market research.* The effect of such research schemes.
16. *Closing down of departments or opening of new departments.*
17. *Profitability of products.* Suggestions to improve profitability when the concern is faced with recurring losses.
18. *Important developments in the industry, e.g. change in Government policy and economic changes inside and outside the country.*
19. *Taxation and legislation* and their effect on the company's profits
20. *Cost reduction schemes.*
21. *Report on general economic forecasts.*
22. *Report on results of special projects.* Alternative capital investment.
23. *Report on the company's financial position.* Various financial ratios.
24. *Report on superannuation, gratuity, and long service payment schemes.*

Reports for Executives. Suggested lists of reports that may be rendered to the various functional executives and the various levels of management are given in the following sections.

Reports for the Top Level or General Management (Strategic level)

- (i) Periodical Profit and Loss Account and Balance Sheet ; general financial position ; management ratios.
- (ii) Reports on the concern's environment e.g. Government laws and taxes, customers, competitors, suppliers, general economic climate of the country etc.
- (iii) Budgets ; master budget and capital budget.
- (iv) Sales volume, orders received, and orders in hand. (Current figures may be compared with past figures to reveal trend.)
- (v) Quantity of production and productivity reports.
- (vi) Damages and spoiled work ; returns made by customers on account of defective work.
- (vii) Summaries of cost of production, department-wise, element-wise, and for important jobs.
- (viii) Overhead efficiency reports.
- (ix) Plant utilization reports.
- (x) Project cost reports.
- (xi) Progress reports on research and development.
- (xii) Variance analysis reports—labour, material, and overhead.
- (xiii) Labour efficiency reports ; labour turnover and labour absenteeism.
- (xiv) Inventory position ; inventory turnover.
- (xv) Return on capital analysis.
- (xvi) Special reports, as necessary.

Reports for the Middle or Co-ordinating Level (Technical level)

- (i) Inventory planning and control reports—stock balance, slow and non-moving stock.
- (ii) Material price and usage variance reports.
- (iii) Labour efficiency reports.
- (iv) Labour rate reports.

- (v) Indirect labour and indirect material costs.
- (vi) Labour productivity reports.
- (vii) Tool costs.
- (viii) Controllable overhead expenses.
- (ix) Quality control ; spoilage, defective work, and rejection reports.
- (x) Idle time.
- (xi) Capacity utilization and capacity planning.
- (xii) Maintenance costs.
- (xiii) Production reports.
- (xiv) Material spoilage report.
- (xv) Finance reports such as budgets and forecasts, customer credit, capital expenditure, etc.
- (xvi) Departmental efficiency report and operating statement.
- (xvii) Marketing information reports, e.g. sales forecast, prices and marketing control, advertising, distribution channels etc.
- (xviii) Personnel and man-power planning and control reports.

Reports for the Lower Level (Operational level)

(a) Production Manager or Works Manager

- (i) Cost of production of jobs.
- (ii) Reports on material consumption. Material usage variance.
- (iii) Spoilage, defective work, and rejection.
- (iv) Labour utilization, idle time, and overtime, causes of idle time analysed for control ; comparison of actual labour hours with standard hours.
- (v) Machine utilization and idle capacity ; bottlenecks in production ; actual machine hours compared with standard hours.
- (vi) Labour turnover and absenteeism.
- (vii) Maintenance cost suitably analysed.
- (viii) Expenditure incurred against specific Standing Order Numbers. (These may be compared with standards.)
- (ix) Analysis of orders ; orders received and complied with.
- (x) Variance analysis—labour, material, and overhead.
- (xi) General operating statement of each department.
- (xii) Tool cost and tool utilization.
- (xiii) Comparison of departmental variable overhead with the budget.
- (xiv) Ratio of indirect labour to direct labour cost for each department.
- (xv) Power consumption and costs.
- (xvi) Overtime and shift working—effect on productivity and costs.
- (xvii) Control ratios, e.g. indirect labour to direct labour, wage cost per worker, idle or lost hours to total hours, material consumed to production cost, etc

(b) Sales Manager

- (i) Sales analysis by products or product groups, territories, regions, salesmen.
- (ii) Sales operating statements.
- (iii) Selling expenses suitably analysed ; comparison with budgets.
- (iv) Market research and market activities.
- (v) Sales promotion ; effectiveness of various sales campaigns.
- (vi) Analysis of sales order bookings and back-logs ; the order booked may be compared with sales quotas. (These help the sales executives to deliver goods.)
- (vii) Warehouse expenses suitably analysed.
- (viii) Transportation costs ; cost of operating vehicles.

- (ix) Reports on credit control, i.e. bad debts, slow collection, report on credit worthiness of customers
- (x) Analysis of customers' complaints
- (xi) Ratios, e.g. value of orders carried out to value of orders received, bad debts to debtors or total sales, selling overhead to cost of sales, profit or marginal contribution to cost of production or cost of sales, etc

(c) Personnel Manager

- (i) Labour utilization and performance in different production departments (ratio of effective labour time to total available labour time)
- (ii) Labour turnover monthly turnover compared with the budgeted turnover rate
- (iii) Defective work, spoilage, and rejection due to bad workmanship and lack of skill.
- (iv) Cost of Personnel department related to total cost of production
- (v) Absenteeism, idle time, overtime, and shift work
- (vi) Accident report
- (vii) Welfare schemes

(d) Purchase Officer

- (i) Material price and usage variance reports
- (ii) Statements comparing actual purchases, consumption and inventories with standards or budgets
- (iii) Changes in material prices

Reports on Material

- (i) Market trends and price movements
- (ii) Supply position report Orders given to supplier and receipt of stores from suppliers
- (iii) Stock and inventory reports
- (iv) Materials quality report
- (v) Scrap and spoilage, loss in storage
- (vi) Material productivity
- (vii) Purchase department costs
- (viii) Material consumption reports
- (ix) Disposal of surplus stock
- (x) Cost ratios, e.g. materials consumed to labour or machine hours, direct material to units of products, cost of production, sales, direct wages, or indirect materials, total material consumption to closing stock or average stock of materials

Reports on Labour

- (i) Recruitment statistics and training costs
- (ii) Statistics of wages paid with details of gross earnings and deductions Comparison with budget allotment
- (iii) Analysis of labour cost variances
- (iv) Effect of overtime and shift work, comparative costing to help in deciding whether new workers should be recruited to avoid overtime payments
- (v) Idle time costs under various causes
- (vi) Labour efficiency and productivity, impact on productivity of suggested changes, e.g. change in wage payment system
- (vii) Labour turnover statistics and costs
- (viii) Frequency of accidents.
- (ix) Absenteeism analysed under various causes.
- (x) Cost ratios, e.g. direct wages to quantity produced, total wages to total labour hours or total machine hours, wages to materials consumed, wages to cost of production, wages to sales, indirect labour to direct labour, overhead to direct wages, and idle time cost to total wages.

Reports on Overhead

- (i) Overhead expenditure statements.
- (ii) Comparison of actual and budgeted expenditure.

- (iii) Overhead recovery rates.
- (iv) Overhead recovered and under-or over-absorption.
- (v) Maintenance cost.
- (vi) Power cost statement.
- (vii) Administration expenses reports.
- (viii) Selling and distribution expenses reports.
- (ix) Research and development reports.
- (x) Cost ratios, e.g. overhead in relation to labour hours, machine hour, quantity of production, costs of production or sales; depreciation to fixed assets; cost of production to sales, power units to materials consumed; coal consumption to power units generated, and steam raised to coal consumed.

Reports on Capital Assets

- (i) Plant utilization statements; idle facility reports.
- (ii) Tied up resources of the business.
- (iii) Cost of operating and maintaining assets.
- (iv) Plant efficiency.
- (v) Revenue earning capacity of each asset.
- (vi) Depreciation.
- (vii) Rejections due to inefficient assets.
- (viii) Report on capital expenditure authorisation.

Data Processing. Data refer to a number of facts, figures or statistics about the activities of a business such as hours worked on individual operations, quantity of material issued for specific jobs etc. Data are usually unrelated and sometimes, un-interpreted and hence, not meaningful.

Information is meaningful data to be used as a base for business decision making and is obtained by suitably converting the raw data into an analysed and meaningful summarised form such as payroll, material issue analysis etc. In the context of computer systems, data, as we shall see later, refer to the input which is transformed into output (i.e., information).

By **data processing** is meant the processing or handling of the various types of data we come across during the operation and management of a business. Data processing comprises the collection, classification and analysis of data so as to finally create the information to be reported. The processing may be manual, mechanical or electronic. While computers are very often referred to as data processing or electronic data processing systems, a simple system of book-keeping maintained manually is also a form of data processing system.

The basic steps involved in a system of data processing are as follows :—

- (i) Collection and recording of data. The data originally recorded in source documents, e.g. clock cards, goods received notes etc. are transcribed on a suitable data record such as handwritten or typed on a paper form, keypunched on a card, keyed on magnetic tape etc.
- (ii) Arranging and classifying the data recorded. This is done in a desired sequence or order manually, with the help of sorting machines in card punching systems or by using the storage devices in a computer.
- (iii) Processing the data and summarising them into suitable heads required in the information or final report. The processing is done in several ways such as manually through mental arithmetic and transcription on paper or with the help of calculating and tabulating machines or by the central processing unit of a computer.

Integrated Data Processing. Integrated data processing is a unified system in which the several phases of data processing in an organisation are streamlined into one interlinked system. In other words, the data handled for the various sectors of control of an undertaking, e.g. for payrolls, inventory control, production control, cost accounting etc. are integrated into one system so that there is an uninterrupted automatic flow of data in an orderly fashion in all parts of the organisation, and all levels of management are fed with the information they need. Dealing with specific problems of only a part of an organisation without reference to their effect on the other parts may be disastrous, misleading, and wasteful. This is equally true in the case of data processing. For the purpose of processing data, the organisation should, therefore, be viewed as a whole and data flow charts should be prepared for the entire organisation.

The *advantages* derived from a system of integrated data processing may be summarised as follows :—

- (i) In an integrated data processing system, data are properly analysed and sifted, unnecessary items are weeded out, and data are able to flow with speed.
- (ii) It assists in laying down necessary control mechanism in as much as each level of management becomes aware of the information flowing to the other levels.
- (iii) The use of the same co-ordinated data ensures accuracy.
- (iv) It gives an overall co-ordinated picture to the management. To cite one example, relationship between sales, purchase, and production is clearly brought out if all the relevant data are properly integrated during processing.
- (v) It stimulates the communication system within the organisation. All levels of management, shops, or executives who are responsible for achieving the objectives become fully aware of their respective roles and places in the overall plan of the concern.
- (vi) Co-ordination brings about a sense of co-operation and mutual feeling. As the same set of data is used for the preparation of several types of statements, the risk of conflict in the views of the various departments is minimised.

Integrated data may be processed manually or mechanically. Mechanised data processing offers considerable advantage over the manual system.

In order to have the full benefits of mechanised system, it is essential that integrated data processing should be introduced. In fact, one cannot think of a mechanised system of accounting that does not go hand in hand with integrated data processing. The punched card and electronic data processing systems discussed here, therefore, pre-suppose that integrated data processing exists in the systems described.

Manual and Mechanical Data Processing. Data may be processed manually or with the help of mechanical, electrical or electronic devices. The manual technique is the earliest and is still widely used in most concerns in this country. As a matter of fact, even those organisations which have installed the latest models of computers, need use the manual method side by side for processing a portion of the data.

The manual method is laborious and time-consuming, particularly in big organisations where voluminous data are handled and a large number of summaries and reports, some of which involve complex calculations, are prepared. A manual system of data processing has the following added *disadvantages* :—

- (i) Clerical errors are not ruled out.
- (ii) It is a drudgery to handle voluminous data manually.
- (iii) The same data have to be copied and recopied for use in different statements.
- (iv) There is no in-built system of agreement and check of the statements prepared manually.
- (v) Delay occurs in rendering information.

A variety of mechanical aids is now available to the accountant to enable him to carry out routine accounting functions, to analyse data in the manner he desires, and to present information to all the levels of management with promptitude and at a considerable low cost. The rapid technological advances made in the field of machine accounting over the last few decades have completely revolutionised the methods of data processing and information presentation. With the help of electronic computers, wide fields are now being covered and managerial control has been made possible to a degree that could not even be thought of earlier.

The following *advantages* in general, are derived if data processing is done with the assistance of machines :—

- (i) The main advantage is speed because machines do work much more quickly than manual systems.
- (ii) There is reduction in cost. The cost of initial installation of machines and in some cases the recurring costs are, no doubt, high but it is economical in the long run because the clerical expenditure is considerably reduced.
- (iii) Several calculating processes like addition, subtraction, multiplication, division, computation of balances, and working out mathematical relations are done simultaneously with posting. If necessary, some intermediate operations can be skipped by a proper setting of the machine.
- (iv) Most of the mechanised systems provide automatically controlled devices to ensure accuracy.
- (v) Mechanisation makes a system flexible. For example in the punched card system, it is possible for a set of punched cards to be collated with another set of cards having a different type of data, so as to give a desired combination of information.
- (vi) Mechanisation helps in improved managerial control through prompt reports covering aspects which it is not possible to go through in manual systems.

Types of Mechanical Devices. The machines and equipments used for the purpose of data processing may be grouped under three broad types :

(1) *Key-driven calculating and accounting machines.* This type includes the various makes of adding (and subtracting) machines, both mechanical and electrical. While some machines are designed to do multiplication and division

work also, some others are of the listing type in which results obtained by the machine are recorded (or printed) on paper or on tape. The accounting machines are meant to calculate and at the same time, do posting or book-keeping work.

(2) *Punched card accounting and tabulating machines.* These are machines using punched cards.

(3) *Electronic computers.*

Description of the numerous types and makes of calculating and accounting machines available has not been attempted in this book. The principles and the methods of the punched card system and electronic computers have been discussed in the following sections of this chapter.

The Punched Card System. The punched card system consists of three main processes, viz. (i) transcribing data from various types of original documents into specially designed cards by punching holes, (ii) sorting and grouping the punched cards in a desired sequence, and (iii) feeding the punched and sorted cards to an accounting or calculating *cum* tabulating machine which performs the calculations by reading the punched cards, and tabulates and prints the information in the desired form. The three phases of the system known as punching, sorting, and tabulation have been discussed below. The equipment designed to handle the punched card is also known as *unit record equipment* because the data punched in a card relate to a single or unit record. For example, if a worker is employed on three jobs, three cards will be punched, each containing the worker's number, the job number, the time taken and the rate of pay.

(a) *Card Punching :* The data to be processed are recorded in a form that machines can read, i.e. holes punched in cards. The process of punching consists of the conversion of data (these are first converted in the form of numerical digits through a system of codes) into holes in a card by means of a punching machine. The card is divided into 80 to 90 vertical columns (30 to 40 columns for smaller cards and 160 columns for large sized cards) and each column has predetermined horizontal punching positions to indicate the numerals 0 to 9. The positions in which holes are punched in a column indicate the meaning attributable to that column. Usually, there is a 'corner cut' in the card so that any card placed upside down or backwards in a tray can be detected. In most machines, there is a provision for punching alphabets also. This is usually done by punching two positions in one column, one in the *digit punching area* (rows 0 to 9) and another in the *zone punching area* (usually consisting of three rows, viz. 0, 11, and 12 above the digit area, 0 being common to both the areas). For example, a hole punched in row 12 and another in row 1 may denote A ; a hole in row 12 and another in row 3 may denote C, and so on.

A group of columns is known as a *field* and each field represents one unit of data. The entire data contained in an original document, which are desired to be transcribed on a card, are broken up into constituent units and each unit is covered by the allotment, i.e. by earmarking of a definite field for it in the card. The relative positions of the various fields are also fixed. The number of digits necessary for the data determines the size of the field. For example, if months (digits 1 to 12) have to be punched, the field allotted would consist of two columns. Similarly, if the employee numbers of 1,800 workers (with token numbers 1 to

1,800) are to be punched, the field allotted to denote the token or employee numbers would consist of four columns. A specimen of an 80 column card showing the allotment of punching fields suitable for transcribing data from a job card is given in Fig. 15.1.

Field allotment is further illustrated below :

EXAMPLE 15.1.

Eighty column cards are to be punched from advice notes containing the following information :—

Customer's account numbers

Customer's name and address

Advice note serial number and date

A list of items supplied, quoting for each : quantity, description and stock item number.

The cards are subsequently written to magnetic tape and used to prepare invoices in conjunction with stock ledger and sales ledger master files, both held on magnetic tape in account number sequence.

Allocate the eighty columns of a punched card to record the necessary information from the advice note. (I.C.M.A., Pt III)

ANSWER :

The card layout may be designed as follows :

<i>Number of Columns allotted</i>	<i>Column Nos. allotted</i>	<i>Contents of the field</i>
3	1-3	Type of card
2	4-5	Sequence number
4	6-9	Customer's account number
5	10-14	Advice note serial number
6	15-20	Advice note date
3	21-23	Quantity of item supplied
7	24-30	Stock item no of item supplied
10 × 5	31-80	The fields for the quantity and stock item no. of item supplied are repeated five times.

The customer's name and address and the description of the item supplied may be maintained in a standing file and may be extracted as and when required.

The zonal punching positions are sometimes utilized for increasing the field capacity by what is known as *over-punching*. Over-punching is a process by which the capacity of the punching field is considerably increased. For example, if in one-column fields, the positions 0, 11 and 12 are taken to denote the figures 10, 20, and 30 respectively, numbers beyond 10 and up to 39 can be expressed by punching two holes simultaneously in the same column. Thus, the number 35 may be expressed by punching two holes in the same column, one at position 12 to denote 30 and the other at position 5. In larger fields having more columns, the increase in the punching capacity is greater. In a two-columns field, the capacity can be increased by over-punching from the normal 99 to 999.

The card in which data are to be transcribed is fed into the card-bed of a machine known as the *punch* or *key punch*. The punch has a key board consisting of a number of keys, each key corresponding to one of the ten or twelve positions that can be punched in any one column of the card. A few other keys are also

[illegible]

15.1. Indexed Card Fields for Labour Accounting

provided for the purpose of spacing, skipping, and releasing. When a punch key, denoting, say, the digit 8 is depressed, a knife cuts a hole in the card at punching position 8 in the proper vertical column and the card moves one position forward to bring the next column in the punching position, as in a type-writer. The machine can, if required, skip a group of columns if the 'skip key' is pressed. The punch may also be operated electrically—this is speedier and requires less effort on the part of the operator.

In another type of key punch, known as automatic punch, the entire data is fed into the machine but no holes are cut until a key is pressed, when all the holes are punched simultaneously. The main advantage is that any mistake in setting up can be rectified before punching, thus economising in the use of cards that may otherwise have to be discarded due to minor errors in punching.

When all the required data have been transcribed, the punched card passes on to the next stage for verification of the accuracy of punching. The operation of the verifier is similar to that of the punch but in place of knife edges, the verifying machine has plungers with blunt edges. When a key is pressed, the corresponding plunger comes down to the surface of the card and senses electrically the hole punched in the card. The machine moves one column forward if there is no hole other than in the position for which the key is pressed. In case of wrong punching, the machine stops and a fresh card should then be punched from the original documents. In another make, a notch is cut on the top edge if the card has been incorrectly punched. The verified punched cards now provide accurate, permanent and unalterable records of the data.

In another method, the punched cards are put through an automatic punch that has a separate contrivance for verification. The holes punched in verification are slightly offset so that the original punched holes are elongated in the verification process. Any error in the original punching or in verification results in two round holes appearing in the same column instead of one elongated hole.

An additional check on the correctness of punching is provided by agreeing control totals with the help of an adding machine and the *Tabulator*. This is described later.

Mention might be made of *dual purpose cards*. These cards are so designed that initially they serve the purpose of primary accounting documents such as materials requisitions, labour cards, etc. and they can be fed later into the punching machine to punch the data contained in the original document. Dual purpose cards economise in the cost of forms and efforts in filing. They cannot, however, be used in all punches. As the cards are handled at several places, they need to be of a stiff texture (and so, relatively more expensive) if they are to stand the wear and tear.

(b) *Sorting* : The function of a sorting machine is to physically group or re-group, at high speed, a set of punched cards of similar classification and arrange them in any desired alphabetic or numerical sequence. The sorting machine works by sensing through the punched holes. A selecting device in the sorting machine sorts out all the cards punched with a particular hole in a single column, the remaining cards being passed on to the reject pocket without disturbing their sequence. A machine usually sorts one column at a time. If a field of nine columns is to be sorted, the cards will have to be passed through the sorter nine times, at the end of which, the cards will be grouped in a complete sequence.

Whether or not a set of cards has been correctly sorted may be checked visually by peeping through the punched holes when any erroneous sorting will obstruct the view, or by passing a needle through the holes which will not go through if any wrong card is included in the set. In humid climates, it may be necessary to heat the cards before putting them in the sorting machine so as to make them crisp enough to resist crumpling. The heating is done in specially designed heaters.

(c) *Tabulating* : The cards, properly sorted in the desired sequence are now ready to be fed into the *tabulator* (also known as *accounting machine*), which contains the calculating unit and the printer. The tabulator is an electrically operated machine that 'senses' one by one, the information given by the holes in the punched cards, does the work of addition and subtraction (also multiplication within limited range), wherever necessary, and finally prints the results in the form desired. With simple calculators or accounting units (with electro-magnetic or electronic devices), all the four basic arithmetical functions may be performed and calculations may be made in a controlled sequence. According to the functions it performs, a tabulator is divided into three units ; the Feed unit (or Data), the Add unit (or Brains), and the Print unit (or Result).

Besides the basic machines, viz. punch, sorter, and tabulator, described above, various auxiliary machines performing diverse functions are employed to assist in the smooth and efficient working of a punched card system. A few of these machines and their basic functions are discussed here.

Collator (or interpolator). This machine increases the facilities of sorting that are ordinarily not available with sorting machines. A collator performs the following functions :---

- (i) Merging separate batches of punched cards, say, current data cards with cards containing previous transactions or standard basic data (standing file).
- (ii) Checking the sequence of cards while merging, to find out whether or not they are in order and whether any card is missing or has been misplaced.
- (iii) Matching parallel operations from two sets of cards. For example, in compiling payroll information, payment cards are matched with cards containing employee (clock or ticket) numbers.
- (iv) File searching, i.e. filing and selecting a specific number. The collator searches cards records that exactly fit prescribed requirements. For example, it can find out in which cards the month 12 has been punched in, say, columns 4 and 5. It also makes files up-to-date by adding new records and deleting obsolete records.

Interpreter. Sometimes in order to check errors or for the purpose of filing the punched cards, it is necessary to read rapidly the information punched in the cards. While some key-punch operators are, by virtue of their experience, expert at reading the punched holes, the work is best done by an Interpreter. This machine translates the holes back into numerals (or alphabets) in ordinary type. The selected details are reproduced along the top margin of the card, the information

contained in each punched column being printed at the top of that column. These cards may also be used as standard business documents such as renewal notices, fund accounts, pay advices, etc.

Reproducer. The reproducer can automatically produce punched cards at high speed. It can copy all or a selected part of information from one deck or set of punched cards and transfer them into another deck. The reproducer is also capable of performing the following operations :—

(i) **Mark sensing :** Sensing data recorded in the form of magnetic pencil marks in cards and transcribing them into punched cards.

(ii) **Summary punching :** Transferring in a desired summarised form, data from a number of punched cards to a single punched card. For example, from out of a number of punched cards, data relating to production in the various production departments for the various months may be punched into summary cards giving the monthly figures for a particular department. Summary cards may also be produced automatically during the process of tabulation when the punching unit of the reproducer is connected with the tabulator.

(iii) **Gang punching :** Automatic copying or transferring information contained in a punched card into one or more succeeding cards. For example, the month, June 81 (0681) as punched in particular columns of a card may be punched into, say, columns 1-4, of all the succeeding cards in a deck.

Advantages of the Punched Card System. The advantages that may be obtained from a mechanised system were stated earlier. The following additional facilities available from a punched card system may be noted :

- (i) It simplifies the accounting system by eliminating the process of posting data in journals and ledgers. The information contained in the original document is recorded directly into the punched cards and all kinds of reports or control statements may be prepared therefrom.
- (ii) The cards form a permanent record of data that may be used at any future date. This also rules out any dispute or disagreement amongst the various parties concerned, i.e. the management, the auditor, the accountant, and the taxation authorities, in so far as correctness of the data is concerned. The information punched on cards can be easily seen and read even without the aid of machines. The punched cards can be easily sorted in any specific order so that it is simple to input the cards in any order.
- (iii) Punched card system is active and dynamic. There is no limit to the use to which the data once punched in the cards may be put to. From one set of punched cards, numerous statements and reports of different types may be prepared.
- (iv) The system can handle large volumes of data that require reprocessing in several stages and that are required for the preparation of various statements and summaries.

Limitations of the Punched Card System. As is the case in all mechanised accounting systems, full advantage of the punched card system cannot be taken if the designing and planning of the system is faulty.

Punched card system may not be useful (i) in very small concerns where the installation of the system may not be economical, or (ii) where not many control statements and reports are required so that part of the data processing capacity may remain idle, or (iii) where the information is used once or twice only and data are not required to be handled frequently or repetitively. On the other hand, the work involved in big concerns may be so large that it may not be possible for a punched card tabulating unit to cope with the work and it would be advisable to have an electronic computer.

Breakdown of accounting machines may result in upsetting the schedule unless alternative arrangements are made to maintain the flow of work. As it would be uneconomical to have standby machines always ready at hand, the only solution to the problem is to keep the machines in a high state of maintenance and repairs. If machines are obtained on a rental basis, it may be possible to get quick replacements for the equipments that have broken down.

Punched cards are liable to loss, destruction or mutilation during continued handling. Proper safeguard is necessary to obviate these.

Requisites for Punched Card Data Processing Systems. For the success of a punched card system, the following considerations should be kept in view :—

- (i) There should be a proper system of codification by which the basic data can be identified.
- (ii) The data to be processed should be completely integrated.
- (iii) The basic documents like goods received notes, wages cards, materials requisitions, materials return notes, etc. should be prepared accurately and promptly.
- (iv) There should be a system of serial numbering of all the original documents. This is to ensure that all the documents have been received for punching and that no document is missing or has been omitted to be punched. The documents should be listed in a register.
- (v) All the original (or source) documents should be made into convenient manageable batches, a batch consisting of say, 50, 100, or 200 documents. The size of a batch depends upon several factors such as, the time lag between the origination of the source data and the date on which information is required, the capacity of data processing facilities, and the cost of setting up necessary facilities. Each batch contains a control total. Known also as the *hash* total, this is the total of the same type of basic information (usually the quantity, value or amount) contained in all the documents in the batch, taken with the help of a calculating machine. The hash total by itself is mostly meaningless, e.g. when the quantities in materials requisitions expressed in different units such as kgs., numbers, litres etc. or the employee numbers in time tickets are totalled up. After punching and verification, each batch of cards is passed through the tabulator to obtain an independent total. This total should agree with the previously made out hash total of the batch.
- (vi) The totals appearing in the printed tabulation should be reconciled with the figures as per the books of accounts. For example, the totals of wages analysis as prepared on the tabulator should tally with the total of wages paid and recorded in the Wages Control Account.

Fields of Application of the Punched Card Accounting System. As stated before, the punched card system may be utilised to produce a large number of reports, summaries, statistical returns, and other documents necessary for control purpose. The field is so wide that it would be futile to attempt a complete list of the areas of application of the punched card system. Some of the important areas are, however, listed below :

1. *Inventory Planning, Accounting, and Control*

Stock control statements or inventory review returns showing the balance in hand, quantity on order, total requirement, suppliers, etc.

Materials turnover report

Materials issues analysis showing the consumption of materials for various production orders and against various standing order numbers

Valuation of work-in-progress inventory

Average unit price of various items of stores

Inventory movement return indicating slow and non-moving items

Analytical statements like statements of inventory shortage, performance of individual suppliers, rates of rejection of certain selected items of material, etc.

Statement of surplus and deficiency in physical stock-taking

Material variance statements

2. *Labour Accounting and Control*

Employees' records

Attendance records

Pay rolls

Wages summary or analysis showing labour charges booked to various production orders and standing order numbers

Statement of ratio between direct labour and indirect labour

Labour productivity statement

Labour utilization statement

Provident fund and other employees' benefits statements

Labour variance statement

3. *Production Planning and Control*

Production programme

Production order

Production progress

Progress summary

Provisioning statement

Machine loading

Tools control

4. *Fixed Assets Control*

Investment analysis

Plant utilization control

5. *Overhead Accounting and Control Statements*

6. *Sales Accounting and Control*

Invoicing

Credit control

Sales analysis

Transport analysis

Sales commission

7. *Cost Accounting*

Standard cost

Budgetary control

Forecast statements

Cost statements

8. *Financial Accounting and Book-keeping*

Ledgers

Journal

Trial balance

Profit and Loss account

Balance Sheets

Dividend warrants

Share transfer

Cash analysis

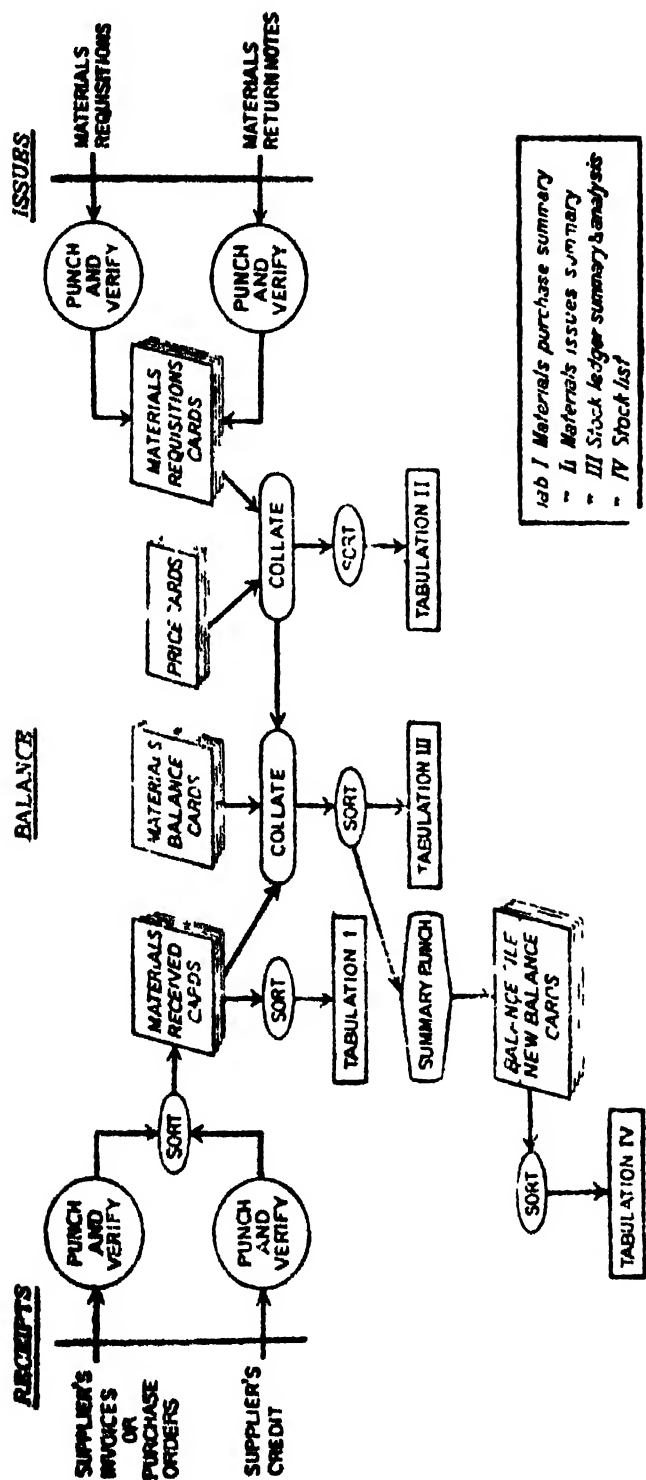


Fig 15.2. Material Accounting Flow Chart

A flow chart for accounting of materials in a punched card system, illustrating the workflow from basic data to tabulations, is given in Fig. 15.2. The various operations involved in the accounting system are detailed as follows :

- (i) The receipt documents (supplier's invoices or purchase orders, if invoices are not received, and credit notes) are punched, verified, and sorted to constitute materials received cards. These cards are sorted and tabulated to give a Summary of Materials Purchased (Tabulation I).

LABOUR ACCOUNTING FLOW CHART

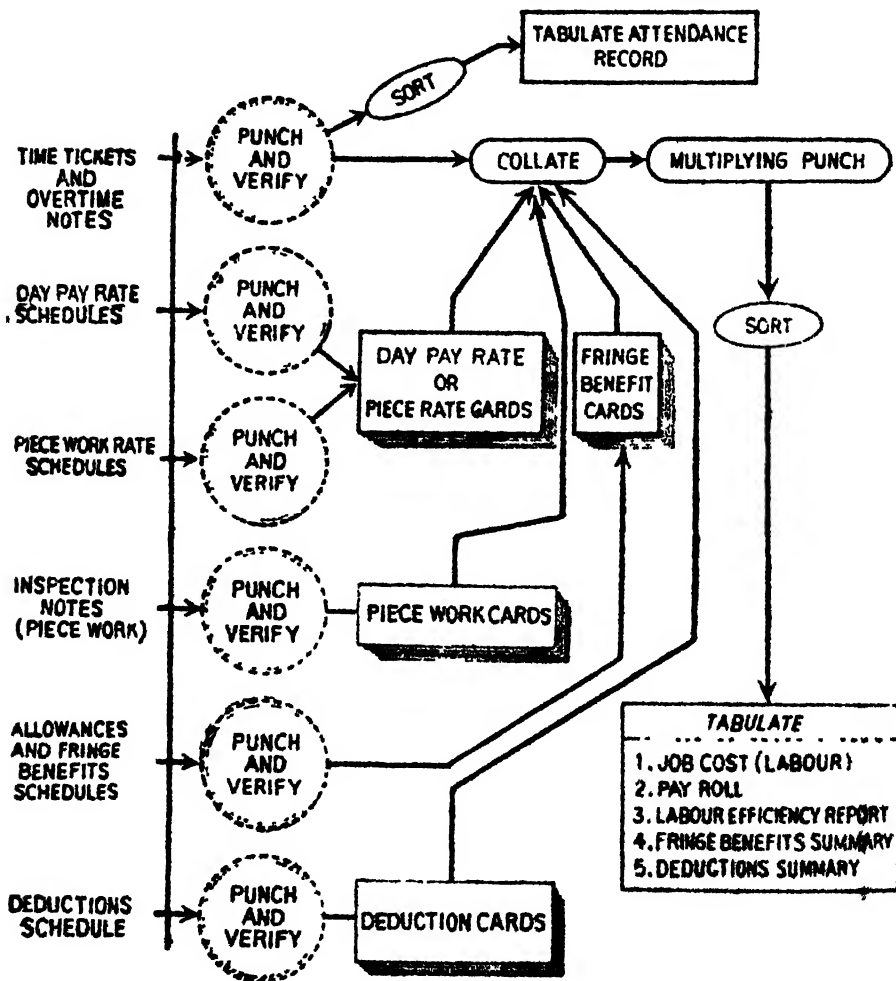


Fig. 15.3. Flow Chart for Labour Accounting in the Punched Card System

- (ii) Materials balance cards showing details of balance of each item are punched.

- (iii) The issue documents, viz. materials requisitions (and also materials return notes) are punched and verified to constitute materials issues cards or materials requisitions cards.
- (iv) The materials issue cards are collated with materials price cards (maintained up-to-date), sorted, and tabulated to give Materials Issues Analysis (Tabulation II).
- (v) Materials receipt, balance, and issue cards are collated, sorted, and tabulated to give the Stores Ledger Summary and Analysis (Tabulation III).
- (vi) New balance cards are prepared by summary punch from the collated materials receipts, balance, and requisitions cards. The balance cards are sorted and tabulated to furnish a current list of Materials in Stock (Tabulation IV). If there is a system of recording dates in the balance cards, a list of slow-moving or obsolete items may be tabulated.

The flow chart in respect of labour accounting is simpler. This has been illustrated in Fig. 15.3.

Electronic Data Processing. Electronic data processing (EDP) usually refers to the processing of data through electronic computers which are electronic devices with associated electro-mechanical equipments. Data collected in a coded form (known as the input) are fed into the computer and processed at very high speeds. The computer is capable of carrying out all normal arithmetical functions. It also makes logical deductions on the basis of the processing done or calculations made by it. It has also devices for storage of data. From the data fed into it, the computer produces the results in the form of reports and documents (known as the output) in code or plain language, as desired. Basically, a computer consists of devices for input, processing, and output.

The physical computer system, i.e. the computer itself as a machine and the equipments related to it such as the input, output, and auxiliary storage devices are known as *Hardware*. The procedure, system, or means adopted to make the computer machine and its equipments to perform their functions, as for example, *computer programmes* and routines and related operating aids are known as *Software*.

During recent years, there has been considerable development in the design and speed of computers. The earliest computers or *first generation computers*, as they are called, were commercially installed in 1951. They were big sized and heavy, using numerous electronic valves and consuming lot of power and the time measure of their speed was milli second (10^{-3} second). The first generation ended in 1958 when the *second generation computers* were introduced. Since these computers used transistors and electro-magnetic material, their size, power requirement and costs were considerably reduced and their time measure was micro second (10^{-6} second). The *third generation computers*, first introduced in 1964, comprised further advancement, making more use of 'chips' and having miniaturised integrated circuits, real-time system, wide range of input/output units, and increased capacity of *direct access storage*, capable of processing several programmes at the same time. Their time measure was nano

second (10^{-9} second). The *fourth generation* brought in more improvements particularly in peripheral equipments, reduction in size (micro-processor) and reduction in costs. The *fifth generation computer* is in the offing and many more improvements both in the hardware and software have been made.

Analog and Digital Computers. There are two basic types of computers, viz. the *analog (or analogue) computer* and the *digital computer*. An analog computer operates by measuring a physical condition or action. It handles numerals indirectly by means of analogous physical quantities of variable nature such as resistance, voltage, length, degree etc. and computations are made by combining the variable quantities. A slide rule or a speed meter or an ammeter is the simplest type of analog computer. For instance, in a speed meter, the input is the number of revolutions of the driveshaft—these are processed or converted into a moving indicator and the output is the reading on a dial shown by the indicator. Analog computers can do complicated calculations very quickly but they have limited storage capacity and input output devices. They are, therefore, more suitable for research and scientific or technical applications, rather than for business purposes. The highly sophisticated analog computers, which can do real time processing (see Page 765), are used for controlling the production processes in electric power plants, oil refineries, steel plants and such other physical systems.

The digital computer operates by counting rather than measuring. It deals directly with numerals and though relatively slower than the analog computer, it can perform basic arithmetical calculations at very high speeds. It can also perform certain other logical operations like distinguishing between the numerals as to their relative sizes and algebraic signs and can solve problems by making additional calculations and comparisons. Digital computers are more suitable for processing business data and information. As such, they deal with large volumes of input and output and emphasize high speed input/output conversion rather than high speed internal processing. The discussions in the rest of this chapter relate only to the digital computer, which we shall refer to hereafter, simply as the 'computer'.

Special Features of Electronic Data Processing. There are several features of electronic data processing which distinguish it from other systems of data processing, such as the punched card system. These are :

- (i) *High speed of operation.* Computers work at very high speeds, so much so that in comparison, a unit record system working at high speed is considered to be very slow. A computer can 'read' punched cards and data in other input devices, perform arithmetical functions and print or punch the output, all at amazing electronic speeds.
- (ii) *Storage of large volume of data in suitable form.* The computer has an internal storage (also called memory) for storing both large volumes of data and the programme.
- (iii) *Automatic operations in accordance with specified programme.* The programme specifies the sequence of the various operations to be carried out and is stored in the computer's 'memory'. Once the programme is written, translated into machine language (mostly by

the computer itself) and stored in the computer 'memory' or storage (this process is known as 'loading') and input data are fed, no further human interference is necessary. The computer does all the rest and gives the result or output automatically, in a desired suitable form.

- (iv) *Inline system of processing business data.* We have seen that in the punched card system, large volumes of transactions are suitably batched so that they can be processed in a single run in sequential steps. This method of data processing is known as *batch processing or sequential processing*. With the development of "direct access storage" (see Page 770), previously known as random access, the computer can now retrieve data from any location inline (i.e. in one step) without going through the previous data in sequence. This type of processing is called *inline processing*.

Two other methods of data processing, viz. *real time processing* and *time sharing* may be mentioned here. In the real time system, the computer responds to feed-back input signals and modifies the performance accordingly. The signal may be physical or digital. Physical signals are used for controlling production processes, such as in an electrical power plant or a chemical plant. On the basis of the signals received, the computer monitors and modifies the physical performance on a continual basis. Digital signals are used for airline reservations, job scheduling etc. For example, a central computer receives, from time to time, input signals, (e.g. messages on telecommunication system from sub-booking stations enquiring about availability of seats and informing about the seats booked by them) processes them, (i.e. updates the seat inventory status for each flight) and modifies the system (e.g. revises and re-aligns all the reservation schedules and communicates them to all the sub-stations).

Time sharing refers to the use of a computer's time by a number of users, mostly small business units or individuals. The user feeds his data into a data terminal (see Page 767) which are then accepted by the central computer and processed according to the instructions given.

- (v) *Programme modification.* The computer is capable of changing the stored programme, as necessary, during the execution of programme steps.

Working of a Computer. The electronic computer system consists of five main components or units, viz. *Input, Control, Storage, Arithmetic Logic, and Output Units*. The control, storage and arithmetic logic components constitute the *Central Processing Unit (CPU)* of the computer. The flow of data within these components is shown diagrammatically in Fig. 15.4. The computer operates under instructions from a programme stored in the CPU. The input devices enable data to be 'read' into the computer, where the control unit gives directions to seek out the first instruction in the programme and execute it. The second and the subsequent instructions are sought out and executed one by one till the last instruction is reached asking the computer to stop. The output devices record the information produced by the computer. Some of the information may be stored in external or auxiliary storage devices. The input, output and external storage constitute the *peripheral equipments* of the computer.

Input Devices. Input devices 'read or sense' the input data and translate them into electronic impulses which are then transferred to the CPU and stored there for use whenever needed. The most common input devices in use since the beginning of the computer age are the punched card, the magnetic tape and the disc. In addition to these, there are other types of input media used, of which mention may be made of punched paper tape, magnetic ink characters and optically recognisable characters. All these devices operate on the "on" and "off" concept ; the 'on' position represents 'one' and the 'off' position represents 'zero'. In a punched card, holes are represented by 'one' and the absence of holes by 'zero'. In magnetic tape, magnetic spots represents 'one' and non-magnetised spots denote 'zero' and in magnetic cores, magnetisation in one direction is 'one' and magnetic polarity in the opposite direction is 'zero'. It will thus be seen that a computer system can distinguish between two digits only, viz. one and zero and so data to be fed into the computer must be first converted into binary codes. (This is discussed later).

Magnetic tape, like the punched card, is used not only as an input device but also for recording output and for storage. The working principles of magnetic tape unit which is faster than punched cards in speed of working, are the same as those of a domestic tape recorder—there are two reels and a mechanism for reading and writing data. Thus magnetic tape unit has now come to be known as the Cassette unit. Data recorded on the tape may be retained permanently or may be erased or 'blanked' by recording another set of data over it. The tape is usually $\frac{1}{4}$ inch in width and of varying lengths and is made of plastic material with a coating of ferrous oxide on one side. The coating permits the recording of data which are represented by magnetised spots or bits.

Discs are described later under the caption "direct access storage system."

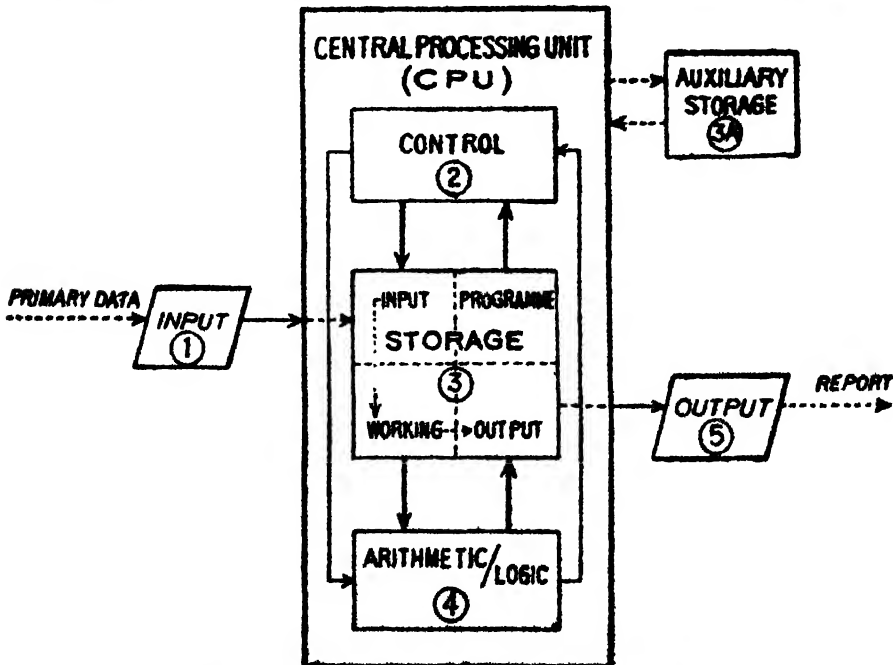


Fig. 15.4. Schematic Diagram of a Computer System

Punched paper tape is not so widely used except when data are required to be transmitted over long distances over the telephone or telegraph wire. Data contained on paper tape at the transmission end are reproduced on duplicate paper tape at the receiving end. Paper tape may also be created as the by-product of an operation. For instance, while operating a cash machine (Cash Register), the transactions may be simultaneously or automatically recorded (punched) on paper tape in a form that can be read into the computer system. Such recording of a transaction at the point where it occurs is known as *Source Data Automation* (SDA).

Magnetic ink character recognition (MICR) device is mainly suitable for bank transactions. The standard data in a cheque, for example, are pre-printed in magnetic ink with suitable codes. On receipt of the cheque in the bank, the amount is printed in the appropriate column by a special machine known as *inscriber* or *encoder*. The cheques are read by the MICR READER SORTER and processed further in the computer.

Optical character recognition (OCR). Characters on a paper document are read by optical readers. The document passes through a source of light, and the light is reflected to a sensing unit. These reflections of the characters are matched with a code and vocabulary built in the reader, to recognise each character. The character is then moved on to the processing unit for reproduction in punch cards, tape or any other device.

MICR and OCR are also examples of source data automation.

Console is a device that allows communication between the operator and the programme controlling the machine. This is usually an electric typewriter on which control messages are keyed in by the operator and acted upon by the programme. Thus the input consists of operating messages for controlling the system.

Terminal is a device that allows input to be entered directly into the control unit from a remote point. Some terminals also provide facilities for output information. A typewriter, a card reader, a visual display unit or even a minicomputer may function as a terminal. A terminal is also able to perform the functions of console if it is used to communicate control messages.

Control Unit. The control unit (also called programme controller) is the most complex component of a computer. It is the nerve centre, controlling all the operating units of the computer system. By the use of specially designed electronic circuits (called *registers*) and channels of wires (called *highways*), the control unit gives instructions and moves data from one device to another, in the manner desired. Once the data are incorporated into the input device, the control unit takes complete charge and handles the data as directed by the computer programme.

Storage Unit. In a computer system, there are two types of storage, viz. *internal storage* (or *primary* or *main storage* or *memory*) and *auxiliary storage* (or *external* or *secondary storage*). The internal storage forms a physical part of the central processing unit of the computer. The auxiliary storage is a separate unit which is connected to the CPU with electric cables, whenever required. The cost of a computer and the size of the problem and the programme it can handle depend upon its internal storage capacity.

The internal storage unit is utilised for :

- (a) Input storage,
- (b) Programme storage,
- (c) Working storage, and
- (d) Output storage.

The area set aside for input storage stores the data conveyed by the input device till such time as they are moved out under instructions from the programme, stored in the area earmarked for programme storage. The programme area occupies a very large portion of the computer's storage capacity.

The working storage area temporarily holds the intermediate calculations made by the arithmetic unit. From here, the data together with the other data from the input storage area pass on to the area assigned for output storage and are retained there as the final result or output till they are moved out, at a convenient time, to the line printer or the card punch or other output devices.

The internal storage area is divided into smaller sections known as locations. Each location is identified by an "address", which may be a name and a unique serial number. Locations are like post office boxes or lockers in banks, each box or locker having a numerical address (e.g., P.O. box 927) which remains constant but its contents change from time to time. The address of a storage location also remains unchanged during a programme—each location is meant to contain the same type and the same quantity or 'word' of information but the stored information changes according to the programme instructions. In an inventory programme, for instance, a location may be utilised for storing data as shown at (a) in Fig. 15.5. When the next record is read into the storage area, the contents of the location will be erased and new data as shown in Fig. 15.5 (b) will be placed in that location.

<i>Location address</i>	<i>Content</i>	<i>Location address</i>	<i>Content</i>
101 Material Code (MAT CODE)	25893	101 Material Code (MAT-CODE)	10829
102 Nomenclature (NOM)	Nuts Round	102 Nomenclature (NOM)	M.S. Sheet
103 Quantity (QNT)	2403	103 Quantity (QNT)	105
104 Amount (AMT)	1502	104 Amount (AMT)	4533
(a)		(b)	

Fig. 15.5. Storage Address

The common storage device used in a computer is a set of small doughnut shaped ferrite cores. The cores can be magnetised in one direction or the other so that they can assume any of the two, 'on' and 'off' positions depending upon the direction of the magnetisation. Each core can store one 'bit' of data (bit is the abbreviation of binary digit) 1 or 0. The cores are arranged in layers or 'planes' so that particular combinations of a number of cores can denote an alphabetic, numeric or special character, i.e. alphabets A to Z, digits 0 to 9 and special symbols such as for rupees, comma, semi-colon, per cent etc. (see Fig. 15.6).

Each storage location contains the same quantity of information in terms of bits, known as *word*. Word is an ordered set of characters handled as a unit by the computer. The length of the word may be fixed or variable. In a fixed word length computer, the number of characters in a word do not vary and an address

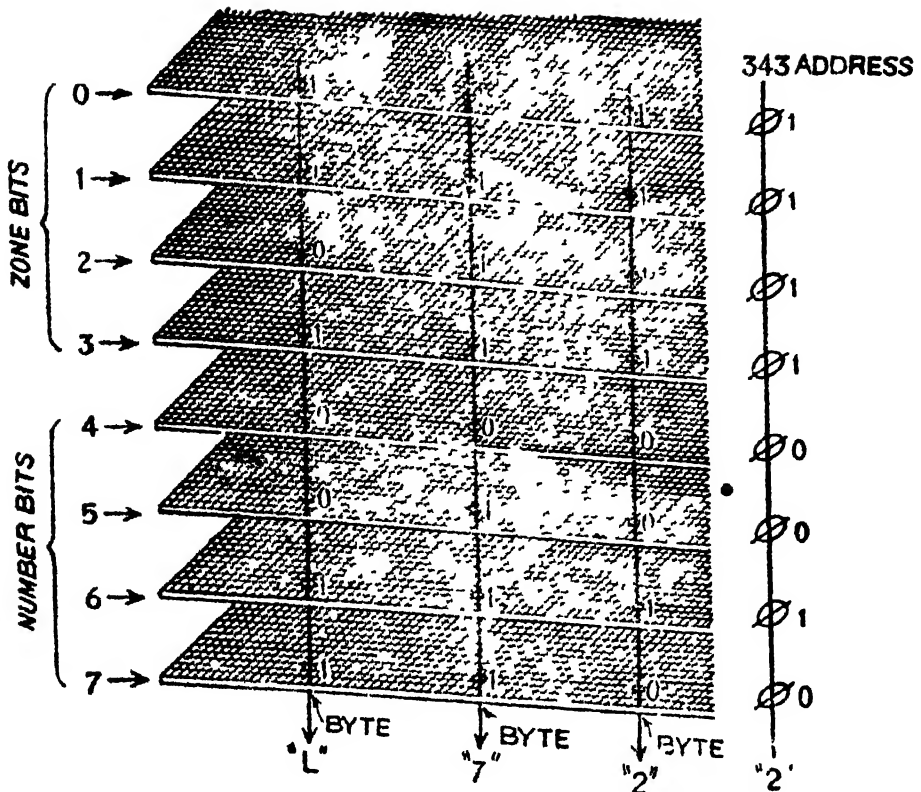


Fig. 15.6 Magnetic core plates showing 3 Bytes (Highly magnified)

refers to one set of characters. In a variable word length computer, each individual bit or byte is assigned an address and the number of characters in the word utilised by the computer varies. While scientific computers have generally fixed word length for maximum computational speed, business-oriented computers have variable word length so as to enable handling of items and records of varying sizes. Some computers have both types of word lengths. It should be noted that although a computer may have variable word length, the word length is fixed during the running of a particular programme, the length having been predetermined according to the initial setting.

Auxiliary Storage. The auxiliary storage does not form any part of the CPU cabinet but is incorporated in a separate cabinet. Auxiliary storage devices have capacities much more than those of the main (or internal) storage.

Auxiliary storage can be used for various purposes such as, (i) storage of computer programmes for retrieval and incorporation in the main storage, whenever necessary, (ii) storage of data, particularly the standard or master data,

which though not immediately required are needed from time to time, e.g. updated files for employees, customers, inventory etc., (iii) storage of historical records required to be kept for some time, (iv) temporary or intermediate storage while the computer performs one process step before passing on to another, (v) link or communication between two computer systems, e.g. in time sharing, the output data from a mini computer may be stored and sent to another computer service for further processing, at a convenient time if the communication is not required to be immediate, and (vi) input/output devices, by recording data direct to the auxiliary storage through the help of special key-driven machines.

The most common physical device for auxiliary storage is magnetic tape. The method of writing and reading data on magnetic tape was discussed earlier. As a storage medium and an input output device, magnetic tape offers, in comparison with punched cards, the advantages of fast speed, compactness, large and variable record length and lower cost (as compared to the punched cards storing equal amount of data). Another important use of magnetic tape in the computer system is for file maintenance. Data relating to a master file (e.g. inventory records, employees' records, customer's records etc.) as stored in magnetic tape may be updated periodically. Updating would necessitate the introduction or addition of new data and/or revising the old data. The old file recorded on the tape is read and written on another tape till the stage is reached where addition, revision or deletion is necessary. The necessary changes are made in the new file and the process is continued till the entire new file is ready. The old file is not erased in the process and it can be retained as long as necessary.

Magnetic tape has the following *limitations* :

- (i) While writing on tape, a small length of the blank tape is passed over, both when the reel is started and when it is stopped on completion. These blank spaces are known as *interblock gaps* or *interrecord gaps*. While reading a record, computer time is again lost in starting and stopping for each gap. This can be minimised to some extent by *blocking* together several records, i.e. by having a continuous run of several records at a time without stopping.
- (ii) While searching a particular information written, say, towards the end of the tape, one has to go through the entire preceding length. In the case of file maintenance, for instance, updating or revision of the old file takes time because the entire file has to be read even for making a minor revision.
- (iii) The information written on magnetic tape may be destroyed accidentally.
- (iv) The information recorded on tape cannot be directly read ; a mechanism is needed to interpret and print it.

Direct Access (or Random Access) Storage. Magnetic tape and punched cards are suitable only for batch processing because transactions are required to be batched and processed in a sequence. For inline processing, therefore, a system of direct access storage (DAS) is to be used. DAS enables data to be retrieved at high speed and because of the very short access time involved, it has almost a limitless capacity. Magnetic tape may also offer this capacity but with very large size of data stored, the time taken for retrieval of a record would be prohibitive. DAS also handles a transaction in its entirety ; while a transaction is stored, all

data or records related to it are retrieved and processed. For instance, while a sales order for an item is being read into the storage, the inventory record is retrieved and updated, a record is added to the billing file, and the sales file and the customers' files are updated. If the item is not in stock, a record is added to the production order file or the purchase file, as the case may be for initiating replenishment.

There are two types of direct access storage devices in use, viz. Rotating Disc Storage and Rotating Drum Storage. The former consists of a stack of aluminium discs mounted one over the other. Both the sides of the discs are coated with ferrous oxide and data are recorded on the surface of the discs in circular tracks. The rotating drum is mounted in a drive and tracks are arranged around the circumference of the drum just as a record player. While a record has a continuous groove, a disc has a number of concentric tracks. Read/write heads (called access arms) serving each track enable data to be read or written while the disc/pack drum rotates. *Floppy disc* units are now more common; the disc is so called because it is soft and bends easily.

Arithmetic (or Logic) Unit. This unit performs calculations at a very high speed, by reducing them to the basic arithmetical operations of addition, subtraction, multiplication and division. Some computers have circuits only for addition and subtraction and the processes of multiplication and division are done through the iterative processes of addition and subtraction; for example, $a \times b = (a + a + \dots)$, b times.

The logical circuitry of the unit is capable of making a logical comparison between two sets of data in terms of "greater than", "equal to", or "less than", or any combination of these. Thus, the unit can make a choice or decision according to the directions given in the computer programme. While almost all computers can determine equality or inequality between two data, some machines can also compare "high-low-equal", i.e. the order of their magnitude. An example of the working of this function is the processing of employees' provident fund accounts where employer's contribution is not payable unless the employee has satisfied certain specified conditions, say, completion of a stated period of approved service. At the appropriate stage, the programme will instruct the logic unit to answer a question like, "completed two years of service?". If the answer is 'no', the unit will follow the next instruction, skipping the account of the particular employee. In almost all computer programmes, the logic unit is asked to find out whether 'last file?', or 'last record?' We shall refer to this again, while discussing computer programming.

Output Devices. The output unit gives out the end product, i.e. the report, result or the final information to be obtained from the computer, e.g. payrolls, inventory records, invoice statements, etc. The output is usually in a printed form in the prescribed format designed specially for each output report. The printing device is known as the 'line printer', so called because it prints an entire line. The output devices are the same as those used as input devices such as punched cards, magnetic tape, punched paper tape etc. The information given out in these devices are fed to the line printer which may be attached to the computer as an in-built component in which case the method is called "on line". Where the printer is a separate unit, this is known as "off line".

The output can also be recorded on *micro films* at speeds higher than that of the line printer. Another special device, known as the *plotter*, converts output data that are in the digital form in the storage unit or in a magnetic tape, into a line drawing so that the output may be produced in the form of line graphs.

Sometimes the output printed by the computer may be suitable for use as input document in another programme. Such a document is called *turn around document* in computer terminology.

As the CPU of a computer is much faster than the various input/output devices, the latter create a bottleneck when attached directly to the CPU. The CPU has to wait till data are being obtained from an input device or are being fed to the output device. The situation is improved by the use of *buffers or data channels*, as they are now called. The data channel serves as an intermediate storage between the CPU and the input/output devices. The CPU need not wait and it can process data previously recorded in the channel while one or more operations are being performed by the input/output devices and the channel is being filled with the next record.

Data channels not only increase the speed of computer operation but enable the computer to do *multi-programming*, i.e. process several programmes simultaneously. Low-speed channels are used for connecting input/output devices and high-speed channels for connecting auxiliary storage unit to the CPU.

Binary Code. We had seen that the computer works on devices that recognise only two states, viz. 1 and 0, called binary digits or bits. Most second generation computers use a 6 bit set—4 for number bits (for numerals) and 2 for zone bits (for alphabets and special characters). The binary code used in third generation computers, has a set of 8 bits—4 for number bits and 4 for zone bits. Each 8 bit unit is a 'byte' capable of 256 combinations of 0 and 1 (See Fig. 15.7).

Byte			Byte		
Character	Zone bits	Number bits	Character	Zone bits	Number bits
A	1100	0001	S	1110	0010
B	1100	0010	T	1110	0011
C	1100	0011	U	1110	0100
D	1100	0100	V	1110	0101
E	1100	0101	W	1110	0110
F	1100	0110	X	1110	0111
G	1100	0111	Y	1110	1000
H	1100	1000	Z	1110	1001
I	1100	1001			
J	1101	0001	0	1111	0000
K	1101	0010	1	1111	0001
L	1101	0011	2	1111	0010
M	1101	0100	3	1111	0011
N	1101	0101	4	1111	0100
O	1101	0110	5	1111	0101
P	1101	0111	6	1111	0110
Q	1101	1000	7	1111	0111
R	1101	1001	8	1111	1000
			9	1111	1001

Fig. 15.7. Binary code (with 8-bit units)

In binary notation, the positional values are powers of 2 instead of powers of 10 as in the decimal or decinary system. This is illustrated below :

Position number	4	3	2	1	0	-1	-2	-3	-4
Value of position :									
Decimal system	10^4 (10,000)	10^3 (1,000)	10^2 (100)	10^1 (10)	10^0 (1)	10^{-1} $\frac{1}{10}$	10^{-2} $\frac{1}{100}$	10^{-3} $\frac{1}{1,000}$	10^{-4} $\frac{1}{10,000}$
Binary system	2^4 (16)	2^3 (8)	2^2 (4)	2^1 (2)	2^0 (1)	2^{-1} ($\frac{1}{2}$)	2^{-2} ($\frac{1}{4}$)	2^{-3} ($\frac{1}{8}$)	2^{-4} ($\frac{1}{16}$)

Conversion of a decimal figure to binary is done by the process of continued division (or multiplication, as the case may be) of the decimal figure by 2 and taking the remainders (or integers carried over to the left of the decimal) as follows :

Given decimal is 23.3125

(a) Conversion of the integer, 23

Continued division by 2	Remainder
2/23	
2/11	1
2/5	1
2/2	1
1	0

Read upwards

The binary equivalent is 10111.

(b) Conversion of the fraction, .3125

Continued multiplication by 2

	.3125
Carry over	2
	6250
	$\times 2$
	2500
	$\times 2$
	5000
	$\times 2$
	0000

Read downwards

(This process is continued till the fraction becomes zero or insignificant.)

The binary equivalent is 0101. Thus 23.3125 is equivalent to 101110101.

Conversion of binary to decimal notation is done with reference to the position values of the binary units, thus :

$$\begin{array}{r}
 (2^4 \times 1) \quad (2^3 \times 1) \quad (2^2 \times 1) \quad (2^{-1} \times 1) \quad (2^{-4} \times 1) \\
 \text{Binary} \rightarrow 1 \quad 0 \quad 1 \quad 1 \quad 1 \quad 0 \quad 1 \quad 0 \quad 1 \\
 \begin{array}{r}
 = 2^4 \times 1 + 2^3 \times 0 + 2^2 \times 1 + 2^1 \times 1 \\
 + 2^0 \times 1 + 2^{-1} \times 0 + 2^{-2} \times 1 \\
 + 2^{-3} \times 0 + 2^{-4} \times 1 \\
 23 \frac{1}{4} = 23.3125
 \end{array}
 \end{array}$$

When adding two binary numbers it is simplest to work in two steps : the first produces a partial sum together with the carries (if any) and the second adds these carries. For instance, the sums of 1101+1001 is written as follows :

$$\begin{array}{r}
 1101 \\
 +1001 \\
 \hline
 0100 \text{ Partial sum} \\
 1 \quad 1 \text{ Carries from 'ones' and 'eights' columns} \\
 \hline
 10110 \text{ Final sum}
 \end{array}$$

In subtracting, a similar procedure is adopted. For example, 1100-1010 is written as follows :

$$\begin{array}{r}
 1100 \\
 -1010 \\
 \hline
 0110 \text{ Partial difference} \\
 1 \text{ Carry from 'twos' column} \\
 \hline
 0010 \text{ Final difference}
 \end{array}$$

The other rules for binary arithmetic have not been discussed in this text. It may, however, be noted that in all the arithmetical operations of binary digits, the results appear in the form of combinations of 1 and 0.

Binary Coded Decimal is a derivation of the binary notation that most computers use nowadays, particularly for business application. The method uses a fixed number of bits (usually four with two more added for special characters such as full stop, comma, etc). Each group of 4 or 6 bits thus represents either a decimal digit or an alphabetic character. The table given below illustrates the method.

Decimal	Binary	Binary Coded Decimal (using 4 Bit code)
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
6	0110	0110
7	0111	0111
22	10110	0010 0010
26	11010	0010 0110
34	100010	0011 0100
47	101111	0100 0111
631	1001110111	0110 0011 0001

There are certain checks exercised to detect and reduce errors in the numbers processed by the computer system. These are *parity check*, *limit check* and *check*

Parity check : When magnetic tape or paper tape is used, an extra bit, known as the parity bit or error controlling bit, is added to ensure that, due to malfunctioning during reading, copying or moving within the computer, no bits are changed, added or dropped. The addition of the parity bit is such that it ensures that the total number of bits in the number is always either odd or even. For example, an even parity would be as follows :

Number in decinary	7	9	4
2^4		1	
Data bits 2^3	1		1
2^2	1		
2^0	1	1	
Parity bit	1		1

Whenever the character byte etc. is moved within the CPU or between CPU and input/output device, a check is made automatically on the number of bits at the receiving end to ensure that no bit is lost. For example, in an even parity machine referred to above, if an odd number of bits is counted on the receiving end, it would indicate that the machine is malfunctioning.

Limit check : This check reduces errors by controlling the range of results. For example in a payroll, if the monthly wages of any worker do not usually exceed Rs. 500, any figure appearing above this limit will signal the computer to give an exception report for investigation.

Check digit : This is an extra digit added to a number to detect errors in copying. The check digit is worked out thus : add all the digits in the number but only after doubling the alternate digits starting from the first. In the result thus obtained, drop out the tens digits or repeat the process of summation till the result is less than 10. For example,

Basic number	48924
Summation	$(4 \times 2) + 8 + (9 \times 2) + 2 + (4 \times 2) = 44$
Check digit	4 (dropping out the first 4 in the tens place)
New number	489244 (adding the check bit 4 at the end)

The computer rejects the transaction if it finds at the input edit stage that the check digit is incorrect.

Computer Programming. Although the electronic computer has tremendous capabilities, it cannot act on its own because it cannot think and take decisions itself. The operations to be performed by the computer have, therefore, to be put down in details in a language it can follow. Further, because, of the electronic speed at which a computer works, it has to be constantly fed with data to avoid idle time. A suitable programme has, therefore, to be written giving detailed instructions, step by step, regarding the nature of data, the sequence or steps in which they are to be retrieved and processed, the functions to be performed, the data to be stored, and the nature and format in which the output is acceptable,

A computer programme is a set of instructions that directs the computer to solve a given problem. All computers operate only in *machine language*. The earlier programmes meant for first generation computers were written in machine language only and a programme written for one type of computer could not be processed on another. Later, *symbolic languages* were developed for use on first generation and second generation computers. Symbolic languages are also machine-oriented but they can work on different models of computers. For the third generation, *assembler languages* that are akin to symbolic languages have been developed.

With the development of a large number of computer models, it was necessary to design problem-oriented languages independent of the model of the machine. Problem-oriented languages are more flexible as they can be run on various models of computers ; they are easy to learn and easy to maintain and they require less time to code. The two popular problem-oriented languages are FORTRAN and COBOL ; the others are BASIC, RPG and PL/1. However, these languages being general in nature, contain some extra instructions not required by the computer and so they take more computer time and need larger CPU capacity.

Programme languages are also classified as follows :—

<i>High level language</i>	: Problem-oriented languages like FORTRAN, COBOL etc.
<i>Middle level language</i>	: Machine dependent languages like Symbolic and Assembler.
<i>Low level language</i>	: Machine-oriented machine language.

The various steps in programming are :

- (i) Preparation of block diagrams and charts of input/output layout.
- (ii) Coding or writing the programme in a suitable language.
- (iii) Translating the programme in absolute machine language.
- (iv) Debugging the programme, i.e. correcting all errors made by the programmer or the keypunch operator
- (v) Testing the programme.

A block diagram (or logic diagram or flow diagram or chart) is a graphic representation of the manner in which processing of data is to be done by the computer. The problem to be programmed is analysed and a flow chart to indicate the movement of the various processes is prepared. The preparation of the block diagram is the most important and difficult part of computer programming. But once the diagram is correctly prepared, the work of actual programming becomes easier. For an expert programmer, however, it is possible to write the programme direct without the help of the block diagram.

Illustrations of block diagrams developed for simple programmes are given in Fig. 15.8 and Fig. 15.9. It should be noted that a computer usually performs the following operations and the block diagram contains those commands which a computer is capable of obeying.

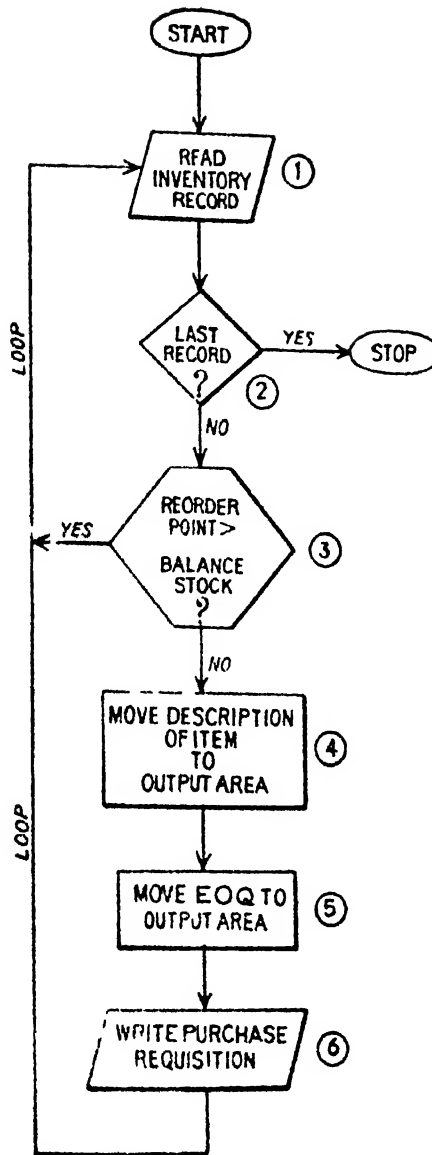


Fig 15 8. Block diagram for inventory programme

After the 'start' command is given, the computer does the first operation (1), i.e. reads an inventory card and moves the data to storage. It then applies logic (2) to find out whether this is the last card, i.e. the end of file. If yes, the computer stops. If no, it goes to the next step (3) where logic is applied. The re-order point is compared with the balance stock in hand (both as read from the inventory record). If re-order point is greater than the balance in hand, the instruction is to go back through the loop to (1) and the next inventory card is read. If the re-order point is equal to or less than the balance in hand, the computer goes to (4) and the necessary details of the item to be purchased are moved from input storage to output storage area, ready for the printing process. The EOQ for the item is also moved to the output storage area (5). The data stored in output areas (4) and (5) are then transferred to the line printer (6) and are printed in the output report. The programme then goes back to (1) and the next card is read.

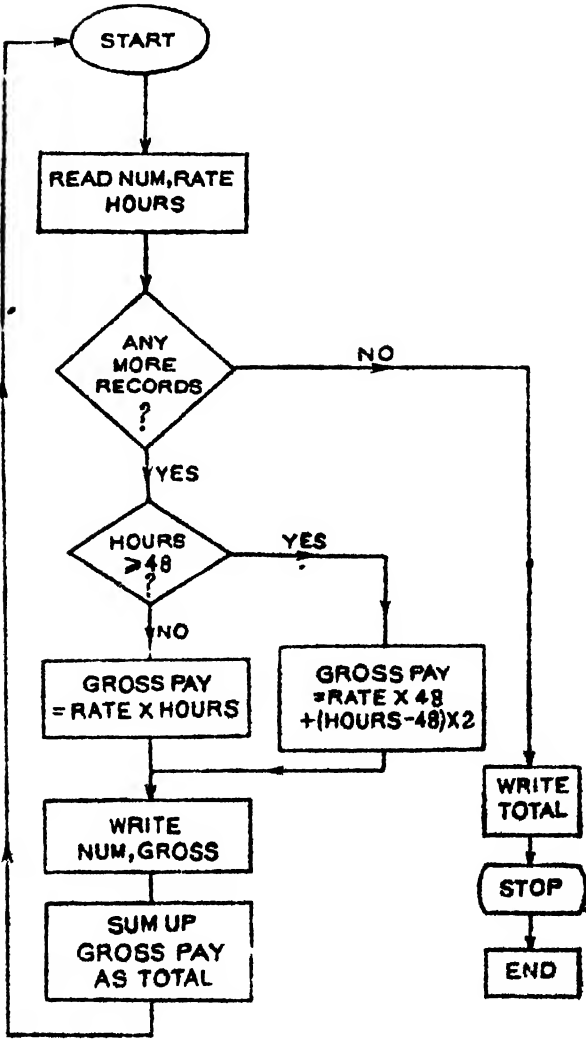


Fig. 15.9. Block Diagram for wage computation

Read (R)

Data (usually the input or the programme) are read and stored in the appropriate memory location.

Move (M)

Data are moved from one memory location to another.

Compare (C)

Information in two memory locations are compared for taking a logical decision, e.g. whether they are equal or unequal, or 'yes' or 'no'. Depending upon the result of this comparison, i.e. if the condition stipulated is satisfied, the diagram branches off to another point containing another set of instructions. This process is known as conditional jump. If as a result of comparison, no branching off is necessary, the operations are repeated in sequence. This "return-repeat" or iterative process of returning back to the original location and repeating the operations is known as 'looping'.

The loop is a set of instructions through which the computer passes more than once in succession when executing a specific programme. The last instruction at the end of a loop has the effect of a return to the beginning of the loop. There should, therefore, be a conditional instruction that will direct the programme to leave a loop. A 'count' is one of the devices to assist a programme to leave a loop. The number of times the computer will go through a loop is incorporated in the programme and is controlled through a counter that keeps a record or count of the moves. The computer leaves the loop as soon as the requisite number is reached.

It may be noted that an unconditional jump is an instruction to the computer to disobey or avoid the next instruction in the sequence and jump to another instruction stipulated and continue processing from that point in the programme. The instruction is usually used to return to the main sequence of a programme after completion of a special routine. Unconditional jump differs from the conditional jump in that it is not dependent upon the result of a test—the jump is made as soon as the stipulated instruction is reached.

Add/Subtract (A)

Information in two memory locations are added together or one is subtracted from the other.

Punch/Tape (P)

The required data is punched on a card or 'read' on magnetic tape.

Write a line (W)

The information (usually the output) is written on a line printer.

Halt (H) or Stop : The processing is complete and the computer stops.

The next step in programming is to code or write the programme in one of the languages selected. As stated earlier, the high-level languages used for the purpose are FORTRAN (Formula Translator), COBOL (Common Business Oriented Language), BASIC (Beginner's All-purpose Symbolic Instruction Code), rpg (Report Programme Generator), and PL/I (Programming Language Version 1). Brief descriptions of FORTRAN and COBOL are given here.

FORTRAN is simple and easy to learn and because of its excellent mathematics and logic capabilities, it is more popular in mathematical and scientific work. It is an algebraic language—its mathematical notations and order of execution are the same as in algebra—easily understood by engineers, mathematicians and technicians and it can handle problems containing many variables and large number of formulae. **FORTRAN** is, however, not as suitable for business applications because of the difficulty in processing alpha-numeric and special symbols, such as name, address, rupee, percentage, credit (cr.), designation etc. A sample **FORTRAN** coding sheet is illustrated in Fig. 15.10.

PAY ROLL		PUNCHING INSTRUCTION					PAGE OF
PROGRAM GROSS PAY CONTROL		GRAPHIC					CARD FORM
PROGRAMMER J.P.S. DATA 12/74		PUNCH					73 80

Statement Number		FORTRAN STATEMENT															
1	5	6	7	10	15	20	25	30	35	40	45	50	55	60	65	70	72
C			GROSS PAY CONTROL														
6			READ (2, 1, END=99) NUM, RATE, HOURS														
1			FORMAT (16, F4.2, F3.1)														
			IF HOURS (GT. 48.) GO TO 7														
			GROSS=RATE* HOURS														
			GO TO 9														
7			GROSS=RATE *48+(HOURS-48)*RATE*2														
9			WRITE (3,10) NUM, GROSS														
10			FORMAT (10X, 16, 10X, F8 2,)														
			TOTAL=TOTAL+ GROSS														
			GO TO 6														
99			WRITE (3,11) TOTAL														
11			FORMAT (24X, F10.2)														
			STOP														
			END														

Fig. 15.10. FORTRAN Coding Sheet

Explanations :

First 5 columns are for statement number, column 6 is used for indicating the continuity of a written line if it extends beyond column 72 (e.g., if it extends to two lines, 2 will be entered in column 6), and the 66 positions from columns 7 to 72 are reserved for **FORTRAN** statements. The letter 'C' (meaning 'Comment') is written in column 1 of line 1 to identify the programme. The comment has no effect on the programme itself.

READ (2, 1, END = 99) NUM, RATE, HOURS

2 is the code number of input device, here card reader ;

1 refers to statement number 1 ;

END = 99 instructs the computer to branch to statement 99 when the last card is read.

FORMAT (16, F 4.2, F 3.1)

16 indicates an integer data (no decimal place) with a field width of six numeric characters to represent NUM in the READ statement ;

F 4.2 indicate field width of 4 characters with 2 decimal positions ('floating' points) to represent RATE ;

F 3.1 indicates field width of 3 characters with 1 decimal position to represent HOURS.

IF (HOURS GT. 48) GO TO 7

This is a logical statement directing the computer to compare the number of hours with 48 and to branch to statement 7 if the hours are greater than 48.

GROSS = RATE × HOURS

This is an arithmetic statement instructing the computer to multiply the hours with rate and store the result, i.e. gross pay.

WRITE (3, 10) NUM, GROSS

FORMAT (10X, 16, 10X, F 8.2)

The first instruction is to write gross pay against each employee number in the format given at statement 10 ;

3 in the parenthesis indicates the output device, e.g. the line printer ;

In the format, 10X indicates that ten blank spaces are to be placed on the left and again between NUM and GROSS ;

16 and F 8.2 indicate the fields for NUM and GROSS respectively.

COBOL is another programme-oriented language meant for business applications. The main features of COBOL are the ease in coding and learning it, the similarity of its sentences and words to English sentences and words and its capability to accommodate alpha-numeric data without any difficulty. The disadvantage of COBOL is that the programmes in this language are lengthy as many extra matters are included.

A COBOL programme contains four divisions, as explained below :

- (i) *Identification division*—The name or label of the programme, name of programmer and other such details are written here.
- (ii) *Environment division*—This consists of two sections, viz. Configuration section and Input-output section. The former mentions the computer system and the source compiler and the object compiler on which the programme is to be processed. (In COBOL, the source programme can be prepared on one computer system and the object programme processed on a different system). The input/output section assigns input/output devices to input/output files.
- (iii) *Data division*—This division assigns storage locations for input/output data and specifies the size of each data field.
- (iv) *Procedure division*—This division specifies the processes required to solve the given problem, i.e. it contains instructions to convert the block diagram into a form suitable for compiler.

The procedure division of a COBOL programme for pay control may, for example, read like this

PROCEDURE DIVISION

START

OPEN INPUT PAY FILE OUTPUT GROSS-FILE

MOVE SPACES TO GROSS-REC

MAIN JOB

READ PAY-FILE AT END GO TO JOB-END

MOVE EMP-NUMBER TO EMP.NO

IF HOURS-WORKED GREATER THAN 48.0

GO TO OVERTIME

COMPUTE GROSS-PAY = PAY RATE * HOURS WORKED

GO TO WRITE-RTN

The coded programme is known as the *source programme*. The source programme is punched into cards and the deck of the programme cards and the compiler programme are read into the computer. *Compiler* is a programme supplied by the computer manufacturer which translates a problem-oriented (high level) language into a machine language and is contained in the on-line storage in the computer. The programme which translates a programme written in a symbolic language into machine language is known as *Assembler*. With the help of the compiler/assembler, the computer translates the coded programme into machine language, i.e. the *object programme*. A sample machine language programme can be seen in Fig. 15.11.

Instruction Number	Instruction Address	Operation Code	A-operand	B-operand
1	051	R		
2	052	M	001	203
3	053	M	002	204
4	054	M	003	210
5	055	R		
6	056	C	001	203
7	057	U	003	
8	058	A	004	252
9	059	B	005	
10	060	L	063	
11	061	E	020	
12	062	M	005	114
13	063	W		
14	064	H		

Fig. 15.11. Machine Language Programme

Note : The operation codes, A, B, C, E, H, L, M, R, U and W denote in sequence, add, branch, compare, erase, halt, branch if last card, move, read, branch if unequal, and write. The operands designate the addresses of information or devices such as card reader or tape drive.

After translation into machine language, the programme is debugged. *Debugging* adjusts the programme to remove variances between actual and expected output. Debugging aids are built in the computer to give diagnostic messages

about any error in the programme language either during coding or during key-punching. The errors are corrected and the programme debugged again to find out further errors, if any. This process is repeated till the programme is errorfree. Debugging does not point out logical or arithmetic errors. It is, therefore, essential to test the programme before it is put into operation or is placed in storage for future use. A sample job with test data cards is run on the computer and the output is compared with a preconceived output prepared manually. Any error coming to light is investigated and set right and the programme is now ready for use.

Mention may be made here of the term *pass word* often referred to in programming. A pass word is a word that a computer programme controlling access to files would require before it allows access to the file concerned. For instance, the pass word for file for ELCOS LTD. may be ECST (taking the alternative digits).

There are a few other software usually supplied by the computer manufacturers. *Utility programmes* refer to those 'house-keeping routines' that are standard or common for several programmes and are of a repetitive nature. A library of utility programmes may be built up so that whenever required, they may be issued to form part of a larger programme. *Expanders* also are routine instructions common to several programmes and the same programme can be used several times. This saves time in writing the same instructions every time. *Autocoder* is an example of an expander language. *Emulator* is a device that enables a computer to execute machine language programmes written for another type of dissimilar design without the need for prior translation. *Application packages* are packages of standard programmes for specific routine and techniques, supplied by computer manufacturers usually on request and on additional payment.

Minicomputers. Minicomputers started to appear in the late sixties. These were small size computers developed primarily from small special purpose scientific machines. In course of time, more and more facilities were added to the first designs with the result that today the minicomputer is in the real sense the equivalent of the big computer (i.e. the mainframe computer). Present day minicomputers have the following special features : -

1. Small size and low price.
2. Programming language varies from machine to machine.
3. Generally used for a single purpose, as for example in business, for payroll, production control, inventory control etc.
4. Usually meant to run one programme at a time.
5. The suppliers of the computers normally supply software package and write programme for the user.
6. The store size, peripherals etc. are limited.

With the rapid developments being made, it may be possible in the near future to remove most of the limitations and to have a minicomputer at a low cost capable of doing all the work of a mainframe computer of medium size.

Microprocessors. These are a sort of minicomputer the development of which has been made possible with the introduction of large scale integrated

circuits, photo-etched on slivers of silicon called *chips*. In size, a microprocessor is as small as a thick postage stamp with a number of gold pins attached as legs. The microprocessor is equivalent to the CPU of a computer ; mounted on a board and combined with a memory unit, power connections and input and output control devices, it forms a minicomputer. With further technological developments coming up, a single chip may also have memory and input and output controls. This will reduce the costs substantially.

The usual language used in microprocessors is BASIC.

Feasibility Study in respect of Schemes for Installation of Electronic Data Processing System. Although electronic data processing system is the most accurate, speedy, and efficient contrivance available to the management, it may not suit the particular conditions prevailing in some concerns. Before going in for an EDP system, management would like to consider the feasibility of the proposal to install the system. Questions like, whether the system will be useful to the concern and if so, to what extent automation can be introduced, have to be satisfactorily answered after making a close study of all the circumstances and the problems involved. In short, feasibility study refers to the planning and evaluation of a proposed data processing system.

Feasibility study may be entrusted to a System Designer who should give his report to the top management for taking a decision. Alternatively, a feasibility study group or committee consisting of experts may be set up and entrusted with the task. Members of the group or committee may be drawn from amongst senior managers, accountants, and organisation and methods experts. Representatives of the firms who manufacture electronic equipments should be closely associated with the committee and they should be freely consulted and called upon to render their advice regarding the schemes. The committee is expected to visit departments and shops and study the procedure, routine, forms, etc., and to collect data and information as necessary.

The following points would generally be examined :

1. Feasibility study is a costly and time taking process. As a first step, therefore, it is essential to determine whether it would be worthwhile undertaking the feasibility study itself. For this purpose, a preliminary system analysis, i.e. an analysis of the existing arrangement is required to be carried out to determine its weaknesses and to find out channels for correcting them. This will form the basis for further comprehensive study to be undertaken, if considered necessary, to find out the future requirements. Detailed system study is a difficult task meant to be carried out by specialists and the cost is considerable. A decision has, therefore, to be taken right at this stage whether system analysis would at all be taken up as the second step. If not, there will be no point in proceeding further with the feasibility study. It will not, however, be out of place to mention here that even if it is decided not to have a computer, the techniques applied in carrying out a system study will not go waste. A system analysis properly carried out may result in considerable economies in the various sectors of the business. While assessing the advantages of the proposed data processing systems, no credit should, therefore, be given to the computers for the savings attributable entirely to the system analysis.

2. It should be seen whether the computer is required for a planned data processing system to cover the entire organisation, or whether it would just be required to serve only a section of it, isolated from the rest. In other words, it has to be ensured that the data processing can be integrated into one unified system applicable to the entire business.

3. The areas or functions to be covered under the electronic data processing system have to be studied and properly defined. Although in most cases, electronic data processing would be justified only if it is required for filling the needs of all the departments, some big business comprised of several units would like to have data processing for a particular function or for limited use, e.g. for production control or for accounting only.

4. Comparison is made of various types, designs, and makes of computers and their costs of installation and operation.

5. A decision is now to be taken as to which type would suit the needs of the business. The decision would be based on the following factors :—

- (i) Estimated cost of installation.
- (ii) Technical features like size, speed of operation, internal storage capacity, variety of purpose served, etc.
- (iii) Volume of work that the computer is expected to handle. This information will be necessary in order to decide the size of the computer and whether to purchase or hire it.
- (iv) Flexibility of the equipment, and possibility of future changes and expansion have to be kept in view.
- (v) Delivery dates, technical assistance obtainable from the suppliers, and maintenance and after-sales service.
- (vi) Requirement of staff for operating the system.

6. Electronic computers and ancillary equipments may be either purchased outright or obtained on rent or a computer service may be hired. The economics of each of these should be evaluated taking into account the following features :—

Purchase of equipments : The special features are :

- (i) Besides recurring operation and maintenance expenditure, heavy capital investment is required. However, the price of computers has now come down considerably so that the capital investment is no longer an important factor.
- (ii) If the services of the computer are required for a long period with no risk of obsolescence, purchasing is economical in the long run. The cost of rental over a large number of years would exceed the cost of purchase.
- (iii) The equipment can be used at will for one or more shifts at a small increase in operation cost. In the case of rental or hire, the cost would increase proportionate to the time worked.

Obtaining equipments on rental basis : The features are :

- (i) Financial requirement is much less in comparison to that for purchase. Operation costs have to be paid but maintenance cost is usually nil. Capital expenditure is limited to a few small ancillary equipments. In the long run, however, the total cost is higher than the one time capital expenditure on outright purchase.

- (ii) Expenditure on programming is of the same magnitude as for purchase of equipments.
- (iii) Being a revenue item of expenditure, rental is a charge against profits and is eligible for tax benefits.
- (iv) Obtaining machines on rent lends flexibility to the system and there is no risk of loss due to obsolescence. Equipments may be returned back if not required, or alterations can easily be made as and when necessary. The cost of installation, training and programming is, however, a prohibitive factor against frequent or drastic alterations.

Hiring of computer service : The advantages are :

- (i) Hiring involves purchase of computer time from a service bureau. The financial requirements are much less : there is no capital expenditure and no operation and maintenance costs are involved.
- (ii) Computer expertise is readily available and the problem of recruiting and training programmes will not usually arise.
- (iii) This has the utmost flexibility. The services may be dispensed with or altered without any financial commitment. At the same time, additional computer power is available whenever needed.
- (iv) There is less expenditure on programming.
- (v) There is no risk of any loss due to obsolescence. New technological changes may be easily introduced with advantage.
- (vi) Hiring is most useful when full time service of a computer is not justified.

On the other hand, the disadvantages are :

- (i) Being dependent on an outside party, full control does not lie with the company.
- (ii) Data have to be moved to and from the Bureau.
- (iii) Security of information becomes difficult.
- (iv) Problems arise if the Bureau goes out of business or is otherwise unable to meet the requirements of the company.
- (v) In the event of input delays, re-scheduling may be difficult since it may not always be possible for the Bureau to accommodate such disruption of the normal routine in view of their own prior commitments elsewhere.
- (vi) It is often difficult to develop a computer system specifically oriented to the needs of the company.

At this stage, feasibility study is practically over and preparatory work prior to the installation is to be done. The management has to tackle a number of problems during this period till the electronic data processing system is firmly installed. These are :

- (a) Changes in the organisational set up to meet computer requirements.
- (b) Provision for building, power, and staff.
- (c) Education of the staff about the consequences of the data processing system. This should be done to allay fears about retrenchment due to redundancy.

- (d) Training of staff to handle the system
- (e) Employment of system designers and organisation and method experts for redesigning the existing procedures so as to fit them into an integrated system suitable for data processing
- (f) Introduction of a system of codification and standardisation suitable to the requirements of the computer
- (g) Preparing a detailed programme in a flow chart and incorporating it in an electronic data processing manual. The programme should lay down the sequence of operations in simple and clear terms and should indicate details of the internal checks and controls introduced in the system. Placing of orders for equipments are phased in such a manner that computers and other equipments are delivered only when the programme is ready.

Systems Analysis and Design. A *system* is a group of elements or component parts that are so interrelated and designed as to achieve a specified objective. Having been designed to achieve something, a system is always active and doing something. Basically, a system receives resources (or input) from its environment which it transforms into its desired objective as output to the environment, with the assistance of its control and process units. Thus, the essential parts or elements of a system are the input, process, output and control. The human respiratory system is a well known example of a system. The input is the air it draws from its environment, i.e. the atmosphere, with the help of the instinctive control element (this regulates the inflow and outflow of air) and the processing elements like the lungs, muscles etc. it attracts oxygen from the air and achieves the objective of sustaining life in the body. In business, we know about production system, marketing system, finance system or the business system itself. In electronic data processing, we come across computer system, data processing system and management information system.

Systems analysis is the study of business system, complete or in parts as required, and the application of the information gained from the study to design, document and implement a new and/or improved system. In the implementation and operation of an information system, systems analysis and design are of major importance. These functions are the responsibility of the systems analyst who, for the successful operation of the system, works in close co-operation with the programmer and the operator of the computer.

Briefly, the systems analyst studies the existing system with a view to improving upon it. At times when there is no existing system, the systems analyst is asked to design a new system. The systems analyst has a systems approach in his methods, i.e. he uses scientific methods just as a scientist would do in his work. After suitable analysis, the systems analyst prepares a design which is the end-product of his work to be used by the programmer and the operator. The design includes flow diagrams and logic diagrams of the system, a record of the lay-out of data and other descriptions and explanations.

In the *system analysis* stage the following steps are involved

- (i) **Define the problem.** The exact problem to be solved is to be ascertained. Sometimes the management indicates to the systems analyst only the symptoms based on which the problem has to be identified.

- (ii) *Organisation for study* : Systems analysis is a team work in which members from various disciplines are associated. At this stage, the task is sub-divided and assigned to the team members.
- (iii) *Collection and analysis of data* : The system analyst collects the data from various sources and by various methods, as necessary, and suitably analyses them.

The steps involved in *systems designing* are :

- (i) *Determine the requirements of the new system* : Before designing the actual system, the initial step is to understand what is required of the new system. The requirements of the various levels of management from the system are to be kept in view.
- (ii) *Find out alternative solution* : At this stage, the systems analyst applies his creativity and technical know-how in order to find out solutions to the problem. There may be several feasible solutions to the problem, all of which the systems analyst has to bring out.
- (iii) *Test alternative solutions and select the best solution* : The various feasible possibilities identified at the preceding stage are put to test under real life conditions. Several techniques may be adopted, the most important of which is the Simulation technique. With these tests, the best design is found out and selected for implementation.

Fields of Application of EDP System. From the days when electronic computers were first brought into use, rapid technical improvements are being constantly made and latest models now offer tremendous advantages over the earlier ones. This has not only improved the speed and considerably reduced the cost of data processing but has opened up new and wider fields of application. Data of numerous types can now be fed into the input unit and processed centrally, a variety of reports made out almost instantaneously for taking decisions, and the data fed back and kept up-to-date for control purposes and for future reference.

It would be futile to attempt a discussion of the full range of useful work the electronic data processing system is capable of handling. Some examples of the tasks programmed for a computer are, however, given below :

Tasks for the accountant :

Quotations for sales	Cost accounting
Order processing	Financial accounting
Invoicing	Capital expenditure control
Credit control	Forecasting
Sales analysis	Budgetary control
Pay rolls	Testing Operational Research techniques
Wages analysis	(Linear Programming, Simulation, PERT
Inventory control	Critical Path Method, etc.)
(Purchase, Stock, and Issue)	Insurance policy accounting
Fund accounting	

Tasks for the technician :

Production planning and control	Machine performance
Quality control	Vehicle routing and control
Resources allocation	Mechanical and electrical designing
Machine tools control	

Advantages of Electronic Data Processing. The advantages of mechanised accounting, integrated data processing, and punched card accounting systems were mentioned earlier. Electronic data processing combines all these advantages and offers a lot more. Some of these are :

- (i) No other mechanised accounting system can beat a computer in speed. Electronic data processing system handles data promptly in the quickest possible time
- (ii) Clerical cost is kept to the lowest possible minimum.
- (iii) Voluminous data required to be processed repetitively can be dealt with ease. This is particularly useful where a large number of documents like insurance premia, bills, invoices, and bank accounts are handled every day
- (iv) Where the data involve too many uncertainties that render manual calculation an almost impossibility, computers may be installed to handle the task with ease
- (v) Data can be processed in a better form not previously available. Almost a unlimited variety of analytical reports and returns and answers to problems may be turned out.
- (vi) Computers can give quick solutions to optimisation problems where decision rests on a large number of factors involving their permutation and combination in numerous ways.
- (vii) Accuracy and reliability of both input and output are ensured. The importance given to input leads to better recording of data and there is practically no risk of any errors in the output.
- (viii) Workflow in electronic data processing is smooth. When properly programmed, the computer gives un-interrupted performance for hours.
- (ix) Time taken for doing a job in the computer is more accurately assessed and schedules are always achieved. These improve work performance.

Limitations of Electronic Data Processing. Considering the wide applicability of electronic data processing and the numerous advantages derived from it, it would appear rather strange that in practice, the system does not properly suit certain undertakings. On a closer study, it is seen that the reasons for the failure of electronic computers in many cases are more due to human failures and certain unresolved limitations arising in the business itself rather than any fault in the machines or the system. Some of these limitations are given below :

- (i) High initial cost. The pay off may come much later.
- (ii) The productivity of the systems development and programming functions is not properly controlled and the management have not the sufficient technical know-how to effect cost control.
- (iii) The computer manager may be merely a technical man having no idea of business concepts.
- (iv) Payment of retrenchment compensations and gratuity if the installation involves retrenchment of the workers and staff.
- (v) Faulty system designing and inefficient programming.
- (vi) Volume of work to be done may not be sufficient for a computer. If work is accumulated to provide an economic feed for the computer,

- the advantage of speed is lost. Sometimes, computer power is wasted on routine work and many areas of profitable application are left out.
- (vii) Absence of co-operation between the staff of the concern and the electronic computer manufacturers
 - (viii) Difficulty with existing personnel. There is a tendency to resist automation for fear of retrenchment
 - (ix) Organisational difficulties arising due to change in the existing set up
 - (x) Time and effort spent in the preparation stage of conversion to electronic data processing
 - (xi) Setting tasks for the computer which it is either not meant to do or is incapable of doing
 - (xii) The top management is not convinced about the usefulness of the system. The computer is installed only because others in the line are doing so or the management is inactive and does not care to review periodically the performance of the computer in order to ensure that the installation is being effectively used
 - (xiii) Risk of centralisation and too much reliance on key staff. Break down may create further complications

Electronic Data Processing and the Auditor and the Accountant. The installation of an electronic data processing system does not change the basic objectives, procedures and responsibilities of the auditor or the accountant. However, in view of the altered conditions obtaining in the working of a computer as compared to manual systems, the methods of audit and accounting controls have to be changed and new techniques evolved to suit the new environment. These throw a challenge to the auditor and the accountant who have to keep pace with the fast changing times. At the same time, a computer offers excellent opportunity as a tool of control not previously available to them for attaining their objectives. The role of the auditor and the accountant in the computer system in regard to these two aspects will be considered here.

The methods and techniques that the auditor or the accountant should adopt to fit in with the electronic data processing system should be as follows :

- (i) In any system of accounting, whether manual or mechanical, there are in-built controls to ensure conformation to the prescribed procedure but such internal controls in a computer system are more efficient and effective. Emphasis should, therefore, be laid on the test of the system rather than on detecting the factors of human errors. The procedure should be so designed as to find out how far the computer programming is correctly done and how far it is being adhered to. It is better if the auditor and the accountant are associated with the programme when it is being built up so that they can suggest improved controls to be included.
- (ii) There should be adequate control of the input, i.e. the source data.
- (iii) Transactions should be tested to ensure that the programme as written is producing accurate and complete results in actual operation. This can be done in two ways, viz. by *sample testing* or by *simulation*. In the former method, representative samples are drawn and tested for accuracy. In the method of simulation, use is made of 'test decks' which are in the form of punched cards or magnetic tape. The 'test

decks' simulate actual transactions involved in the processing of the system. They are introduced in the system as if they were normal transactions and the output is scrutinised for accuracy and reliability.

- (iv) The auditor or the accountant should also see that the flow charts of procedures and programme lists are clear enough for correct interpretation ; that the control totals are independently kept by staff other than the machine operators ; and that there is no tampering with the programme once it is finalised. The programme is the main point in an electronic data processing system where fraud, mistakes, and waste may occur. Any manipulation thereof should be properly guarded against.

As regards the opportunities offered by the computer, we find that a large number of checks and comparisons required by the auditor & the accountant are now being done quickly and the computer provides useful assistance not previously available. Some of these are

- (i) The computer can quickly select certain items for listing in numerous ways to enable a follow up of such items. This saves the auditor's time and increases the effectiveness of audit.
- (ii) The computer is able to analyse data at top speed in any manner desired. This offers the accountant a wide opportunity which he can avail of for the prompt preparation of important statements for decision-making purposes, from out of a mass of complex data.
- (iii) The computer may be used to locate trends, e.g. to check sharp fluctuations in accounts or to check up price rises in a particular period.
- (iv) Statistical sampling can be made with ease in a computer.

EXAMINATION QUESTIONS

1. "While submitting cost reports accuracy should not be achieved at the expense of either promptitude in presentation or excessive cost of preparation." Discuss.
(I.C.W. 4, Final)
2. The Managing Director of a company feels that the periodical reports received by his departmental managers are too many in number and that these do not assist in taking timely action. As a cost consultant you are required to study the reports received by any one departmental manager and to offer your suggestions as to the extent and nature of reporting to be done in future. Draft the necessary report. (I.C.W. 4, Final)
3. Mention a few examples of special reports that may be submitted by a Cost Accountant to General Management. What are the routine reports a Works Accountant should give to production management on labour? (I.C.W. 4, Final)
4. A Cost Accountant is asked by the Managing Director to give him every month in one sheet all the 'significant figures' relating to his company. What items would be included in such a statement? (I.C.W. 4, Final)
5. What factors determine the form of presentation and scope of data to be included in a folder proposed to be given every month to the top management of an industrial undertaking by its Accountant? Mention the information you would include in such a folder, indicating the industry. (I.C.W. 4, Final)

6. The Managing Director of a factory has suggested that all relevant information should be displayed in a control panel in the foreman's office as the foreman is a member of the management at the point of production. Discuss what type of information should be exhibited and for what purpose. *(I.C.W.A., Final)*
7. What control information would you as a Cost Accountant of a large industrial company operating standard costing system give every month to the company's (a) Purchasing Officer, (b) Personnel Manager ? *(I.C.W.A., Final)*
8. On taking up the appointment as a Cost Accountant in a factory you find that no report is submitted to the management on the subject of stocks. List the reports with brief details which you consider necessary for managerial control. *(I.C.W.A., Final)*
9. What is meant by an integrated approach in data processing ? Of what use is it to the Management ? Compare the relative merits of data processing by mechanical methods as against manual methods. *(I.C.W.A., Final)*
10. One of the locations in your company has a punched card installation consisting of punches, verifiers, sorter, a collator (or interpolator), and a tabulator. What do these machines do ? *(I.C.M.A., Pt. III)*
11. You are a cost accountant of a group installing punched card equipment. The group consists of six manufacturing units, the maximum number of cost centres in any one unit being sixty. There are, however, numerous classes of materials purchased products sold and methods of wage payment.
Assuming that you are limited to six digits for analysis purposes, and making whatever other assumptions seem necessary, set out how you would make use of them to collect your information on the expenditure and income of the group. *(I.C.W.A., Final)*
12. The installation of a punched Card Accounting system is very often felt to be costly as the benefits derived are difficult of direct monetary assessment. How would you convince your Management that the Punched Card installation in your organisation has been effective and useful ? *(I.C.W.A., Final)*
13. What are the pre-requisites for Punched Card Accounting ? Discuss the working and economics of the system. *(I.C.W.A., Final)*
14. Enumerate the possible operations that can be performed with Punched Card Accounting machines by having an integrated material accounting system with cards punched for receipts and issues etc. for each item of inventory. *(I.C.W.A., Final)*
15. How would you proceed with planning to mechanise the store accounting records on a Punched Card System ? What control statements will be prepared with these cards for stock control purposes ? *(I.C.W.A., Final)*
16. The management of an engineering factory desires to introduce the punched card system for the maintenance of priced store ledger. Under the manual system, weighted average rates are worked out at the time of each receipt and issues are priced accordingly.
(a) What steps would you take for the preparation and submission of various documents for the above purpose to the Mechanical Accounting Centre ?
(b) Since the ledgers will be prepared mechanically on a monthly basis and will not be available till a month is over, how should the issues for the same month be priced ?
(c) State the cases where the same punched card could be used more than once and for what purpose.
(d) Give a list of the data that are required to be punched on cards. *(I.C.W.A., Final)*
17. Set out a flow chart for accounting of materials in an electrical punched card system, illustrating the work-flow from basic data to tabulations. *(I.C.W.A., Final)*
18. (a) Write the characteristics of (i) Analog Computer, (ii) Digital Computer, (iii) Hybrid Computer.

- (b) What are the several types of input devices for a computer ? Write the merits and demerits of each type.
- (c) What are the field and zone of a case ?
- (d) What is the function of check list in a code ?
- (e) Define 'bit' and 'byte' and their relation to a character. (I.C.W. 1., Final)
19. An industry employing a large labour force and having a very large number of stores transactions, mechanised its accounts five years ago, using conventional Hollerith Equipment. (Punchers, Verifiers, Sorter, Tabulator, Collator and Multiplier).
- Owing to rapid expansion and augmentation of staff and increased use of materials, the capacity of the machines is strained and consequently delays are occurring in wage payments and compilation of ledgers.
- Make out a case, if any, for introduction of Electronic Data Processing for the industry. (I.C.W. 4., Final)
20. Define and describe :
 (a) batch processing,
 (b) real time processing.
 Give an example of the use of each method.
 List the advantages and disadvantages of each method. (I.C.M. 1., Pt. III)
21. Describe the stages necessary to ensure that data punched from source documents on to punched cards are correctly transferred to a file held on backing storage. (I.C.M.A., Pt. III)
22. Describe in detail how data is arranged and stored on magnetic tape. In what circumstances is a fixed length recording mode preferable to a variable length recording mode on magnetic tape ? (I.C.M.A., Pt. III)
23. (a) What are random access storage devices and why are they important in many applications ?
 (b) Describe how buffering takes place ? How is the data character an improvement over buffering ?
 (c) What are the primary functions of console at the time of operation of a computer ?
 (d) Explain the method of simulation in case of inventory control problems. (I.C.W. 4., Final)
24. Random Access, Time sharing, Service Bureau and On-Line-Real Time are a few of the modern technologies of computers. What do you understand by each of them ? (I.C.W. 4., Final)
25. (a) Convert the following binary numbers to denary numbers. Add the numbers together and show your answer in binary and denary.
 110101001
 111010101
 (b) A company has to prepare a weekly payroll for 5,000 people and has a computer configuration which includes a paper tape punch, card punch, magnetic tapes and magnetic discs.
 (i) How many payroll runs would you recommend to prepare the payroll ? Give reasons for choice.
 (ii) State the method of storage you would select for the cumulative payroll records and the advantages to be gained from this method compared with alternative methods of storage. (I.C.M.A., Pt. III)
26. Enumerate the steps to be followed in programming. What is the importance of flow chart in programming ? What are decisional blocks ? What is looping in programming ? (I.C.W. 4., Final)
27. (a) What is high level programming language ?
 Name four and illustrate your definition with three instructions from a language with which you are familiar.

- (b) Draw a program flow chart to read cards and accumulate the quantities read into 10 fields in core, depending on the code in the card and print out the 10 totals, each on separate line.

Card layout	Columns
Code	.. 1-2 (range 01-10)
Quantity	.. 3-5 (max 999, min 001)

(I.C.M.A., Pt. III)

28. Briefly list out internal control procedures that are normally built into electronic data processing systems.
- (a) What are several types of input devices of a computer system? Write the merits and demerits of each type.
- (b) What are the basic advantages of unit recording machines? Are they being replaced by mini-computers?
- (c) Convert 842 to binary and 10010101001 to decimal. Why binary system is being used in computer?
- (d) What are peripheral equipments in a computer installation? Do you agree with the proposal that by controlling input-out devices with the help of peripheral equipments the utilisation of computer may be improved considerably? Justify your views.
(I.C.W.A., Final)
29. Your company is installing a computer. Describe the types of software which you would expect a computer manufacturer to provide and explain what purpose each serves.
(I.C.W.A., Final)
30. Answer any six of the following
- COBOL is nearest to English language but its compiler is most complex in comparison to other languages of programming. Explain.
 - Explain time sharing concept used in computer service bureau.
 - What are softwares used in a computer? Explain with an example.
 - Why outright purchase of a computer is discouraged by customer as well as the manufacturer? Explain in the light of problems that may arise in course of operation.
 - What do you understand by storage in a computer and how is that related to the generations?
 - How does programming take care of checks and measures for erroneous data? Explain with an example in payroll system.
 - What do you understand by the term Integrated Data processing? Can you explain this with the help of a production control system?
 - Write a short note on the concept of real time data processing. Do you think it is useful in an industry of medium scale?
(I.C.M.A., Pt. III)
31. A big concern handling a major product, which consists of a very large number of components, proposes to go in for an electronic computer and has formed a committee of experts to study the feasibility of the proposed scheme. Discuss the several factors which the committee should take into account before making a final recommendation.
(I.C.W.A., Final)
32. Three choices are available to the user of electronic computers; to buy the equipment, to rent it, or to hire a computer service. Evaluate each alternative in terms of its respective advantages.
(I.C.W.A., Final)
33. You have been asked by your Managing Director to consider the use of a Computer Service Bureau instead of installing an "in-house" computer. List the advantages and disadvantages of using a Service Bureau.
(I.C.W.A., Final)
34. You are considering the use of a computer bureau for analysis of purchases and payment of suppliers. List the source data required for setting up such a system.
(I.C.M.A., Pt. III)
35. What factors would you take into account when deciding whether to rent or lease as opposed to purchasing computer equipment for your company? (I.C.M.A., Pt. III)

- 36 (a) In some of the big computer installations the system analysis/programmers are posted to the user's departments and computer centres have minimum number of experts, except operational group.

Give your comments on such a set-up with particular reference to the working areas of system analyst/programmer before and after the piloting of a system.

- (b) You are working as a Cost Accountant in a Works. It is reported that in a number of cases overpayments had been made due to mistakes in computation of overtime. Suggest a system for mechanisation on the following lines

- (i) Input data from Works/Accounts
- (ii) Output format from computer.
- (iii) Checks and controls.

Express your findings in the form of a flow chart (I C W A., Final)

- 37 Owing to the vast growth of commercial undertakings coupled with automation of records by the introduction of electronic data processing methods and sophisticated internal controls, many auditors are now placing greater emphasis on evaluating systems than on examining individual transactions

Explain in brief the concept of systems analysis and list the steps involved in a systems audit (I C W A., Final)

- 38 You have just been appointed the management services manager of a large organisation, whose computer installation is very inefficient. This has led to disillusionment among the employees and the transfer of further applications has been stopped

Outline the action you would take to improve the situation (I C M A., Pt III)

- 39 In processing accounting information through electronic data processing system, how does one ensure through internal controls accuracy of results? (I C W A., Final)

- 40 The advent of I DP in the arena of accounting has necessarily entailed changes in the techniques and methods of auditing. Discuss how the auditor should set about in accomplishing his objective in the new set-up (I C W A., Final)

CHAPTER 16

CAPITAL INVESTMENT DECISIONS AND CONTROL OF CAPITAL EXPENDITURE

The purpose of this chapter is to discuss the nature of controls exercised over capital expenditure and the role that costs play in assisting management in arriving at a decision when alternative capital investment plans are in view. The concept of return on capital employed which is an important tool for the evaluation of performance of capital expenditure is dealt with in a separate section of this chapter.

Necessity for Sound Capital Investment Policy. The necessity for a sound capital investment policy arises from the following :

- (i) Proper investment of funds in capital projects is necessary not only from the narrower point of view of benefit to the business but is also of importance for the national economy as a whole. Well planned plant replacement and expansion programmes whenever put to effect in order to avail of new and improved techniques in the industry, contribute towards increased productivity and economic growth of the country.
- (ii) The cash resources utilised for capital investments are mostly heavy. Locking up of large sums of money in fixed assets precludes the concern from taking advantage in other useful spheres as and when such opportunities arise.
- (iii) With rapid technological advances in the industries and in the face of severe competition, capital assets are liable to obsolescence, or the processes or the product lines for which the assets are procured are likely to become out of date. Unless such situations are foreseen and guarded against, heavy losses are likely to be incurred.
- (iv) Heavy capital expenditure makes a concern less flexible. If costly special purpose or automatic machines specially designed to meet particular product requirements are installed, difficulties arise if subsequently there is some alteration in the design of the product.
- (v) Capital investments have effect on future profits for over a number of years. Once an investment has been made, the undertaking commits itself to a particular future path from which there is no easy going back. Hence, the risk in capital investments is larger and any errors in capital investment may have a serious financial effect.

Classification of Capital Investment Projects. Sound planning for capital investment consists in establishing a procedure under which alternative schemes are evaluated with reference to certain criteria and the most desirable proposal is

selected. While normally capital expenditure is incurred with a view to earning future profits, there are certain projects which do not yield any monetary return. The criteria used for project evaluation depend upon the nature of the capital project.

Capital projects may be classified as follows :—

- (a) *Profit earning projects* : These are projects taken up with a view to earning profits such as an investment in a plant which is expected to increase productivity and sales volume and reduce costs. Profit earning projects are of two types, viz. *Replacement projects* and *Expansion projects*. In replacement projects, the existing capital assets are replaced by new ones ; the replacement may be necessary when the existing asset has either outlived its life or has become obsolete so that it cannot meet the requirements of current production. Expansion projects are meant for augmenting the existing facilities so as to increase the productive capacity. Estimation of the future return on expansion project investment is very important. Consideration should be given to the present worth of the returns expected in the future years. Evaluation of the risk involved in such capital proposals is also essential.

Profit-earning projects may also be classified under several other heads such as projects for (i) improving quality of products, (ii) research and development, (iii) improving facilities, (iv) cost reduction and cost improvement, and (v) maintenance of earnings.

- (b) *Non-profit projects* : Capital investments are sometimes made for meeting some contractual obligations, or the requirements of some laws or orders of the government or local authorities, such as safety measures for employees, pollution control etc., or for provision of welfare and amenity measures, research and development projects, etc. Earning of profits is not the objective of such expenditure. For example, no profit is expected on investment on an effluent clearing plant in a chemical factory where it is compulsory by law to suitably dispose of the waste which would endanger public health. Projects of this type are obligatory and hence the question of their evaluation with the yardstick of profitability will not arise.

- (c) *Projects, the profitability of which cannot be measured* : Certain investments are made with a view to increasing profits but the extent of the expected profits cannot be fairly assessed. Sales promotion and research schemes, and projects meant for the welfare of the staff and for the improvement of their morale are examples of such investment. The provision of, say, a modern health clinic or a school for the children in the factory estate has the effect of improvement of morale of the workers and the staff but the extent of cost reduction on account of these facilities cannot be easily calculated.

Evaluation of projects at (b) and (c) above is made by cost-benefit analysis.

Capital Investment Analysis. In capital investment analysis, future costs only are relevant ; historical costs or sunk costs are of no importance except to provide a guide for assessing future costs. In selecting a capital project from amongst a number of contending proposals, the main factor to be considered is the rate of return expected from the investment. The various other factors required to be taken into account before a final choice is made are listed overleaf.

(i) *The amount and timing of the expected return.*
 (ii) *The effect of the project on the profitability of the remaining sectors of the business.*

(iii) *The relative importance and necessity for a project :* For example, setting up of a hospital, dispensary, or canteen, though not yielding any return on the capital employed, may be given preference on the grounds of urgency and essentiality to another project which would have given a fair return.

(iv) *Technical considerations :* Soundness of the project from the technical point of view should be considered. It should be seen whether the asset would amply serve the needs of production and manufacturing processes. Such factors as the make, capacity, working life, power requirement, adequacy of space, cost of repairs, and availability of spares and maintenance facilities should be examined. The volume of production should be sufficient to keep the plant profitably engaged and at the same time, the plant capacity should be such that there is no bottleneck in production.

(v) *Cost of investment :* The cost of the assets, the cash position, and the availability of cash either from internal sources or by borrowing are to be considered. It would not normally be a correct policy to invest borrowed funds in capital projects if the rate of interest paid on such funds is more than the return expected from the investment. Since the expenditure on big projects would usually be phased over a period of time, the cash requirement during different periods should be kept in view. The working capital required when the project goes into operation should also be assessed. Lack of working capital at a later stage may sabotage the entire scheme.

(vi) *Cost of production :* Different capital investments may have varying impacts on the costs of material, direct labour, waste and scrap, fixed and variable overhead, supervision, maintenance, power consumption, etc. The effect of the alternative schemes on future costs of production should be studied.

(vii) *Product demand :* When additional assets are required in order to increase production capacity or when plant replacement is expected to give higher production, it should be seen whether there will be sufficient demand for the increased production without reducing price, or whether in case of fall of demand, alternative use can be made of the new assets. The effect on the sales of other products yielding higher profits should be taken into account.

(viii) *Opportunity costs :* Opportunity or alternative cost is relevant in making capital investment decisions. For example, the return obtainable from the funds, if utilised otherwise than for investing in a proposed project, is compared with the yield expected from the project.

(ix) *Depreciation :* The treatment of depreciation for the purpose of capital investment analysis and selection of capital projects will depend upon the nature of the capital investment being considered.

Two methods that are used under different circumstances, are discussed below :

(a) In a plant replacement project, the present depreciated book value of the discarded asset is a sunk cost and is not relevant to the decision making and it is only the realisable value of such an asset that matters. This is based on the contention that in the face of competition, a concern is compelled by circumstances

to replace an equipment which has become old and outdated, by a better and improved equipment and as such, the written down book value of the old asset (except for its sale value) is a loss that cannot be recovered in future. The book value of the old asset should not, therefore, be taken into account for computing the costs of production with the new asset.

(b) When competitive conditions are absent, replacement of an asset will be decided upon only when it is seen that the future profit may be able to compensate the loss that would result if the old asset is discarded. While assessing the operating cost and the cost of production with the new asset in such cases, the depreciated book value of the old asset less its disposal value (after deducting selling and other expenses) is added to the cost of the new asset and depreciation on the aggregate amount is computed over the life of the new asset.

It may be stressed again that the depreciation worked out for the new machine under method (b) is only for the purpose of deciding whether or not to acquire the machine. If and when the new machine is actually acquired, the normal accounting method for the calculation and charging of depreciation will be followed.

Methods (a) and (b) are illustrated below :—

	<i>Old Machine</i>	<i>New Machine</i>
Original cost	Rs. 10,000	Rs. 24,000 (inclusive of installation costs)
Present book value	Rs. 4,600	
Present sale value	Rs. 1,600	
Life	10 Years	12 Years
Residual value	Nil	Nil

The annual amount of depreciation to be added to the operating costs and cost of production will be as follows :—

	<i>Old Machine</i>		<i>New Machine</i>	
Method (a)	Rs. 10,000 — 10	Rs. 1,000	Rs. 24,000 — 12	Rs. 2,000
Method (b)	Do		Rs. 24,000 — 12	(Rs. 4,600 — 12) Rs. 1,600 Rs. 2,250

(x) *Interest* : Though there is controversy regarding the inclusion of interest in cost accounts, there is no doubt that imputed interest should be taken into account for capital investment analysis. For comparison, interest should be computed on the full capital cost of the new asset less the realisable value of the old asset. Another procedure is to charge interest on average investment, i.e. half the original cost. Some accountants are of the opinion that interest should be computed at an estimated rate on the original costs of the old as well as the new asset.

(xi) *Taxation* : The taxes payable on each of the alternative capital projects should be assessed. The profits, after deduction of the tax paid, go to recover the cost of the project.

(xii) *Obsolescence* : This is a factor difficult to assess. Since obsolescence has the effect of prematurely cutting down the life of an asset, the probability of

obsolescence estimated on the basis of past experience may be taken into account while making a decision on capital projects. On the other hand, too pessimistic a view would result in a profitable project being rejected.

(xiii) *Other considerations* : Besides cost considerations, there are other non-financial factors that influence a decision. Examples of investments made on the basis of these factors are, non-profit projects and prestige investments for maintaining status and prestige in the industry, and acquirement of plant, machines, and other assets in order to meet competition. When a project has the effect of eliminating or reducing labour, it is to be seen that the surplus labour is suitably provided for or otherwise disposed of without difficulty.

Methods of Evaluation of Capital Investments. The methods employed for evaluating capital project returns are :

1. *Comparative cost method*
2. *Pay-back or Pay-off period method*
3. *Interest rates of return on investment method (Time value of money not taken into account)*
4. *Discounted cash flow or Present value return on investment method*
 - (a) *Yield method by trial and error (Internal rate of return)*
 - (b) *Net present value or Net gain method*
5. *Annual cost method*
6. *Profitability index method*

Normally, the project that yields the highest rate of return will be selected. In determining the relative profitability, common factors present in varying degrees in alternative schemes such as initial cost and life of the asset, return expected, phasing of the expenditure, timing of the return, working capital required, effect of the scheme on the profitability of the other sectors of the business, and investment required on essential non-profit projects are considered.

1. *Comparative Cost Method* : In this method, comparison is made between the initial costs of the various proposed projects ; the choice rests on the project that costs the least, other things remaining constant. The method though very simple has a very limited application. It may be used when the assets proposed to be procured have the same life and identical output or their lives and output are not easily assessable.

2. *Pay-back or Pay-off Period Method* : This method takes into account, besides the original cost of the project, the amount and the timing of the return obtainable from it. The pay-back period is the time required for the profit (i.e., the aggregate of the cash receipt or in-flow from the investment) just to equal the capital employed ; shorter the period, the better is the investment made. The method is illustrated below :

EXAMPLE 16.1.

A company proposing to expand its production can go in either for an automatic machine costing Rs. 2,24,000 with an estimated life of 5½ years or an ordinary machine costing Rs. 60,000 having an estimated life of 8 years.

The annual sales and costs are estimated as follows :

	Automatic machine	Ordinary machine
Sales	Rs. 1,50,000	Rs. 1,50,000
Costs : Material	Rs. 50,000	Rs. 50,000
Labour	Rs. 12,000	Rs. 60,000
Variable overhead	Rs. 24,000	Rs. 20,000

Compute the comparative profitability of the proposals under the pay-back method.

(I.C.W.A., Final)

ANSWER :

The profitability is worked out as follows :—

	Automatic machine	Ordinary machine
Marginal profit	Rs. 64,000	Rs. 20,000
Pay-back period	$\frac{\text{Rs. } 2,24,000}{\text{Rs. } 64,000} = 3.5 \text{ yrs.}$	$\frac{\text{Rs. } 60,000}{\text{Rs. } 20,000} = 3 \text{ yrs.}$
Estimated life	5.5 yrs.	8 yrs.
Surplus	$\text{Rs. } 64,000 \times (5.5 - 3.5)$ = Rs. 1,28,000	$\text{Rs. } 20,000 \times (8 - 3)$ = Rs. 1,00,000

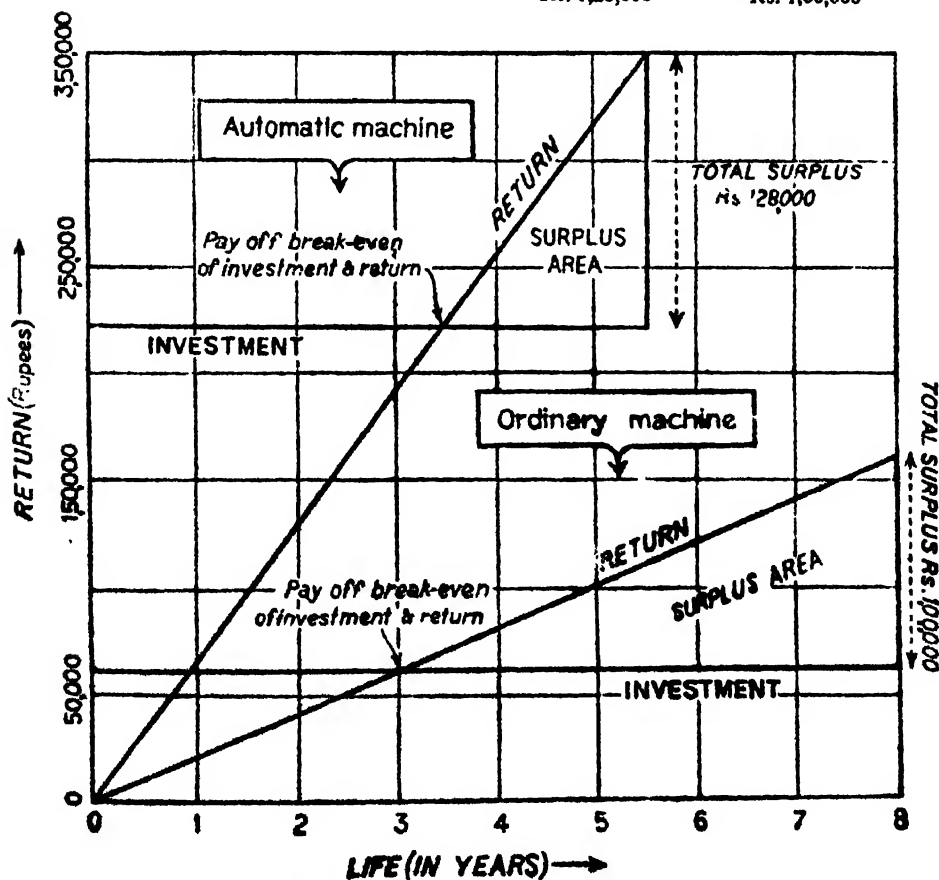


Fig. 16.1. Pay-off Break-even Chart

On consideration of the pay-off period alone, the ordinary machine having a slightly shorter pay-off period should be recommended. In the long run, however, the automatic machine which yields a surplus of Rs. 1,28,000 in 5.5 years would be preferable to the ordinary machine which gives a surplus of Rs. 1,00,000 in 8 years. This has been illustrated in the break-even chart in Fig. 16.1. The difference in the results points out to one of the limitations of the pay-back method, viz. that it ignores the return obtained after the pay-back period is over.

The *advantages* of the pay-back method are as follows :—

- (i) It is a simple method—computation of the pay-back period is easy.
- (ii) From the point of view of an investor proposing to give loans to a concern, this method gives an indication of the period by which the loan may be expected to be repaid.
- (iii) It serves the purpose of a helpful index for safeguarding against investments on projects likely to become obsolete within short periods.
- (iv) It is most useful when cost is not high and the capital project is completed in a short period.
- (v) It gives indication to a company facing shortage of funds to invest in projects with small pay-back periods. This is particularly useful when funds are difficult to obtain and a quick return is essential for rapid repayment.

The *limitations* of this method are :

- (i) A mere consideration of the pay-back period by itself does not measure the true profitability of a project. Some really profitable investments may be left out if preference is given to investments with short pay-back periods. The method may, therefore, be used only as a supplementary index of the desirability of an investment along with some other method.
- (ii) It does not take into account the full serviceable life of the asset. No consideration is given to the return that may still accrue from the asset even after the pay-back period is over, unless a further analysis of profitability for the remaining life of the asset is made.
- (iii) It ignores the time value of the return since the return expected in future years is not discounted at the present value. The time pattern of the earnings from different projects may differ from year to year but because equal value is put on all earnings whether received in later years or earlier, no true comparison of the various alternative projects can be made. For example, if there are two projects each having a pay-back of two years but one of these gives 90% of the total earnings in the first year and the other gives 10% of the total earnings in the first year, the first project is obviously preferable to the second but the pay-back would indicate that they rank equal.

3. *Interest rates of return on investment method* : This method, also known as the *accounting or financial statement method*, consists of a consideration of the returns that the investments are likely to fetch. The selection of a particular investment will depend upon the rate of return—the one showing the highest rate would normally be selected.

The rate of return may be worked out as :

- (i) The expected average gross annual income before depreciation, expressed as a percentage of the investment or as a return per rupee invested.

- (ii) The expected average net annual income after depreciation, expressed as at (i) above.
- (iii) The expected average net annual income after depreciation, expressed as a percentage or per rupee of one half of the investment. (The concept of taking only half of the cost of investment is based on the view that the amount periodically recovered in the form of depreciation is ploughed back in the business or invested outside.)
- (iv) The expected average net annual income after depreciation, expressed as a percentage per rupee of the aggregate of one-half of the investment and total average working capital.

Methods (i) to (iv) are explained below with the help of assumed data :

Capital investment	..	..	..	..	Rs. 5,000
Average working capital	..	..	..	..	Rs. 500
Expected gross income— 1st year	..	..	..	..	Rs. 1,000
2nd year	..	..	..	..	Rs. 1,200
3rd year	..	..	..	..	Rs. 1,500
4th year	..	..	..	..	Rs. 1,800
5th year	..	..	..	..	Rs. 2,200
Total	..	..	..	..	Rs. 7,700

Depreciation : Rs. 1,000 per year

Return under the various methods will be as follows :

Method (i) $\frac{\text{Rs. 7,700}}{5 \times \text{Rs. 5,000}} = 30.8\%$, or Re. 0.308 per rupee invested, for 5 years

Method (ii) $\frac{\text{Rs. 2,700}}{5 \times \text{Rs. 5,000}} = 10.8\%$, or Re. 0.108 per rupee invested, for 5 years

Method (iii) $\frac{\text{Rs. 2,700}}{5 \times \text{Rs. 5,000}} = 21.6\%$, or Re. 0.216 per rupee invested, for 5 years

Method (iv) $\frac{\text{Rs. 2,700}}{5 \times (\frac{\text{Rs. 5,000}}{2} + \text{Rs. 500})} = 18\%$, or Re. 0.180 per rupee invested, for 5 years.

The concept that the investment which yields the highest return is the most profitable one is, however, to be accepted with caution and complete reliance only on the rate of the return may at times be misleading. Although all care may be taken to ensure the accuracy of the figures compiled for arriving at the return, the estimation of the future is fraught with difficulties. Forecasts of the life of an asset, the future sales, and the anticipated costs over a long period are influenced by a large number of factors. For instance, the life of an asset would depend upon factors such as its make and quality, the extent of its working, i.e. of the use made, the state of maintenance, and the manner in which it is handled during work. The other limitations of this method are :

- (i) Emphasis is placed on profit rather than cash flow ignoring the fact that the real economic benefits of an investment arise from its cash flow.
- (ii) The method ignores the time value of money.
- (iii) It ignores the time period during which the return will continue.

The factors which limit the utility of the return on investment method should, therefore, be carefully examined before making a final decision in the choice of an investment. In view of these difficulties, the rate of return should be taken as a guide for decision making rather than as an absolute measure of the profitability of an investment.

4. *Discounted cash flow (DCF) or present value return on investment (PVR) method.* The main criticism against the foregoing methods is that they do not take the time factor of the income into account. Though receipts in earlier periods are more important, no distinction is made between income received in earlier or later years. For example, a project which yields a return of Rs. 2,000 in the first year and Rs. 500 in the second year will, under those methods, be at par with another project which yields Rs. 500 in the first year and Rs. 2,000 in the second year although the present value of the return in the first case is higher. The discounted cash flow method answers to this criticism.

The method is based on the principle that a sum of money in hand now is worth more than an equivalent amount received later after the lapse of a period of time. An investment of Rs. 100 will, at a compound rate of interest of 15% per annum, amount to approximately Rs. 200 after five years. Putting it the other way, the worth of Rs. 200 to be received five years hence is the same as Rs. 100 if received at present. This is even without taking into consideration, inflationary trends, if any; in fact, DCF technique does not take inflation into account. Since a capital project yields returns for a number of years, correct assessment of its profitability may be made only if the annual returns of the future years are brought to their present value allowing for compound interest at a predetermined rate. Similarly, if the capital expenditure of a project is extended over a number of years, the costs for each year should be brought down to their present worth.

The analysis under the discounted cash flow method may be made in two ways. The main feature of both the methods is that the returns obtained from a number of capital projects with differing life assessments and having an uneven pattern of cash flow of return from year to year, can be brought down to a common base so that the results are comparable with a fair degree of accuracy. Obviously, it will be meaningless to use the discounted flow method in case of short-term projects of, say, a year or so.

(a) *Yield method by Trial and Error* (Also known as *Internal rate of return —IRR method*): The present worth of the returns expected to accrue during the assessed lifetime of the asset is fixed at an amount equal to the present capital cost of the asset and the rate of interest or discount at which this can be made possible is computed by a process of trial and error. In other words, the discount rate is the interest rate at which the present value of the cash in-flow from an investment just equals the present value of the cash outlays for it. In order to judge the profitability of a project, the discount rate is compared with the adequate or expected rate of interest. In case of alternative projects, the one yielding the highest rate of discount interest equating the present value with future proceeds will be selected.

In the example given in the next page, to illustrate the method, the capital project cost is assumed to be Rs. 80,000, yielding cash inflow of Rs. 10,000, Rs. 20,000, Rs. 30,000, Rs. 40,000 and Rs. 30,000 at the end of the 1st, 2nd, 3rd, 4th, and 5th year respectively.

Year	Cash inflow	Present value at interest rate of 15%	Present value at interest rate of 16%
	Rs.	Rs.	Rs.
1	10,000	8,696	8,621
2	20,000	15,122	14,864
3	30,000	19,725	19,221
4	40,000	22,872	22,092
5	30,000	14,916	14,283
	Rs. 1,30,000	Rs. 81,331	Rs. 79,081

The present values of the cash inflows at different rates of interest are calculated with the help of Present Value Tables (see Appendices) or on the basis of the formula given below.

From the Table, discount factors (i.e., the present value of Re. 1, n periods hence) are found as follows :

After year	Interest 15% per annum	Interest 16% per annum
1	.8696	.8621
2	.7561	.7423
3	.6575	.6407
4	.5718	.5523
5	.4972	.4761

(When the Table does not provide figures for the exact rate of interest, the discount factor may be obtained by computing the variation of values given for two adjacent rates.)

From the formula :

$$\text{Present value, } P = \frac{E_1}{1+r} + \frac{E_2}{(1+r)^2} + \dots + \frac{E_n}{(1+r)^n}$$

where E_1, E_2, \dots, E_n are the returns or cash in flows expected in the 1st, 2nd, ...nth year respectively and r is the rate of interest.

Thus, at the interest rate of 15%, the present value,

$$P = \frac{10,000}{1+.15} + \frac{20,000}{(1+.15)^2} + \frac{30,000}{(1+.15)^3} + \frac{40,000}{(1+.15)^4} + \frac{30,000}{(1+.15)^5}$$

$$= 8,696 + 15,122 + 19,725 + 22,872 + 14,916 = \text{Rs. } 81,331$$

The present value at the interest rate of 16% is calculated in a similar manner.

The two rates of interest, viz. 15% and 16% per annum have been selected by trial and error so that the cost of investment falls between the present values of the cash inflow calculated under the two rates. The exact rate of interest which will discount the cash inflow back to the present value of the investment is found by interpolation. Thus,

For a change of present value of Rs. 2,250 (Rs. 81,331 minus Rs. 79,081), the change in rate of interest is 1%.

For a change in present value of Rs. 1,331 (Rs. 81,331 minus Rs. 80,000), the change in the rate of interest = $\frac{1,331}{2,250} \times 1\% = 0.591\%$.

Therefore, required rate of interest = 15.591%.

When the annual cash flow is uniform, $E_1 = E_2 = E_3 \dots$, present value,

$$P = \frac{E}{1+r} + \frac{E}{(1+r)^2} + \frac{E}{(1+r)^3} + \dots + \frac{E}{(1+r)^n} = \frac{E}{r} [1 - (1+r)^{-n}] = E \cdot \frac{(1+r)^n - 1}{r(1+r)^n}$$

In the above case, the Annuity Table (giving present values of Re. 1 received in every period, for n periods) may be used. Sometimes, the capital recovery factor, which is the reciprocal of the discounting annuity factor at the prescribed rate of interest, is used for calculation. For example, the present value of annuity

of Re. 1 at the end of 6 years at 10% interest rate is 4.3553 ; the capital recovery factor will be, $1/4.3553 = .2296$

The *limitations* of the IRR method are as follows :—

(1) Unless the life of the asset can be accurately estimated, assessment of profit cannot be correctly made.

(2) The single discounting rate ignores the varying future interest rates. If for instance, the rate of interest is high in a particular year and money is difficult to obtain, the return in that year is relatively more valuable. When money is cheap, the positions is reversed. The yield method does not account for this factor.

(b) *Net present value (NPV) or Net gain method* : This method is based on the same principles as the IRR method except that instead of determining by trial and error, the rate of interest is anticipated in advance, depending upon the type of capital employed and the source from which it is met. With this rate of interest, the present worth of the returns expected during the entire assessed life of the asset is calculated in order to judge how far it exceeds the present capital cost. The higher the excess of the present worth over the present capital cost, the better would be the investment. The comparative profitability of two projects calculated under this method is illustrated below :

Capital investment	A	Rs. 10,000				
	B	Rs. 8,000				
Life	A and B	5 years				
Rate of return	A and B	20% per annum				
Income	A	Rs. 3,000 per year				
	B	1st year	Rs. 4,000			
		2nd year	Rs. 3,500			
		3rd year	Rs. 3,000			
		4th year	Rs. 2,500			
		5th year	Rs. 1,000			
			Rs. 14,000			
Year	Present value of Re. 1 @ 20%	Investment A Annual income	Present value	Investment B Annual income	Present value	
	Rs.	Rs.	Rs.	Rs.	Rs.	
1st	0.833	3,000	2,499	4,000	3,332	
2nd	0.694	3,000	2,082	3,500	2,429	
3rd	0.579	3,000	1,737	3,000	1,737	
4th	0.482	3,000	1,446	2,500	1,205	
5th	0.402	3,000	1,206	1,000	402	
Total	2,990	Rs. 15,000	Rs. 8,970	Rs. 14,000	Rs. 9,105	
Investment			Rs. 10,000		Rs. 8,000	

For investment A, the present value of cash flow is less than the investment, but for investment B, the cash flow exceeds the investment. Project B is, therefore, recommended.

It should be noted that while IRR is a rate, NPV is a money quantum.

The adoption of a suitable rate of interest for the purpose of computation under the NPV method presents difficulty. The rate commonly adopted is the current borrowing rate for the purpose of financing the project. The excess of the cash inflow (discounted at this rate) over the cash outflow would then indicate the real surplus. Some accountants prefer to adopt the current rate of

return on capital employed. Adoption of the rate of interest at which the funds are borrowed may sometimes be misleading. For example, if loan capital has been obtained at a particular low rate of interest and the return is discounted at this low rate, the present worth will show a high figure and *prima facie*, make the investment appear economic although if the rate of return on capital employed is considered, this may not be adequate. Further, in the case of assets which have a long life and projects which continue for an appreciable number of years, it may not be possible in practice, to forecast with a degree of accuracy, the rate of discount and the profits likely to accrue over such a long period. The results obtained by this method in such cases are not likely to be correct, particularly if during the lifetime of the assets, the profit pattern undergoes appreciable changes.

Another example to illustrate the DCF method is given below :

EXAMPLE 16.2.

In respect of the following competing capital projects A and B, you are required to use discounted flow techniques to :

- Prepare, on a single graph, comparative present value profiles from 0% to 16% for each project ;
- read the internal rate of return for each project from the graph ;
- state for what range of capital costs project A is to be preferred to project B and suggest reasons for this.

The figures may also be obtained from special discounted flow tables, prepared for the purpose. The following information is given :

	Project A Rs.	Project B Rs.
Initial cost	1,00,000	1,00,000
Net Savings		
Year 1	5,000	60,000
2	20,000	40,000
3	1,00,000	20,000
4	10,000	5,000

Below is shown the value today of Re. 1 to be received or paid after a given number of years at various rates of interest :

	Present Value of Re. 1			
	4%	8%	12%	16%
After : 1 year	0.962	0.926	0.893	0.862
2 years	0.925	0.857	0.797	0.743
3 years	0.889	0.794	0.712	0.641
4 years	0.855	0.735	0.636	0.552

(I.C.M.A., Pt IV—Adapted)

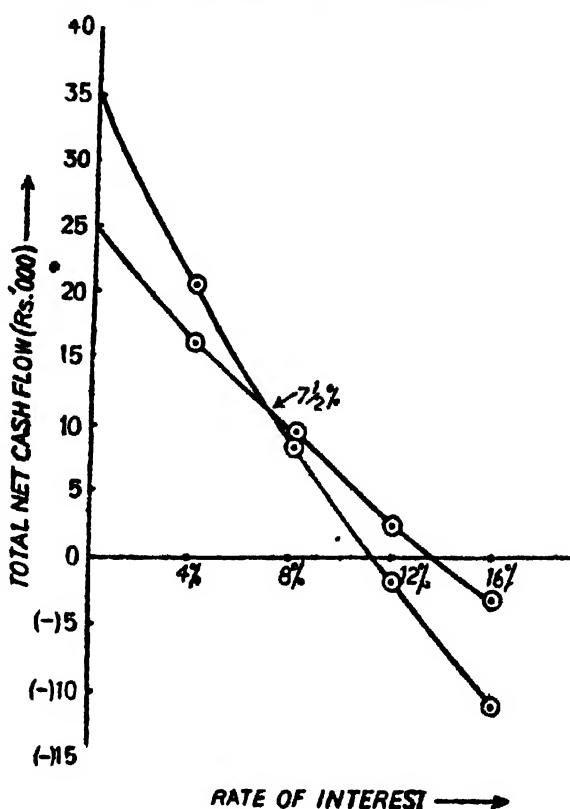
ANSWER :

- (a) The present values of the net cash flows are worked out at follows :

Year	Net cash flow				
	Actual value Rs.	4% Present value Rs.	8% Present value Rs.	12% Present value Rs.	16% Present value Rs.
Project A					
0	(—)1,00,000	(—)1,00,000	(—)1,00,000	(—)1,00,000	(—)1,00,000
1	5,000	4,810	4,630	4,465	4,310
2	20,000	18,500	17,140	15,940	14,860
3	1,00,000	88,900	79,400	71,200	64,100
4	10,000	8,550	7,350	6,360	5,520
	<u>35,000</u>	<u>20,760</u>	<u>8,520</u>	(—) 2,035	(—) 11,210

Project B					
0	(—)1,00,000	(—)1,00,000	(—)1,00,000	(—)1,00,000	(—)1,00,000
1	60,000	57,720	55,560	53,580	51,720
2	40,000	37,000	34,280	31,880	29,720
3	20,000	17,780	15,880	14,240	12,820
4	5,000	4,275	3,675	3,180	2,760
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	25,000	16,775	9,395	2,880	(—) 2,980

The graph drawn with the help of the figures is given below :



- (b) The internal rates of return are at the points where the curves intersect the abscissa, i.e.

Project A	11%
Project B	14%

- (c) From the graph we find that at rates of interest below 7%, Project A gives higher discounted return and is, therefore, to be preferred.

At 4% interest, net cash flow of A is more than that of B by Rs. 10,000. This advantage is gradually wiped out as the interest increases, due to the better pay-back of B. Pay-back is not an important factor at lower rates, and the main consideration is the higher return given by project A.

It will be seen that the results obtained from the various methods discussed above are by no means uniform and no definite answer can be given to the problem of choosing the particular method to be adopted. The cost accountant who in the practical field is faced with the problem of reporting on the profitability of a

proposed capital project or a number of alternative proposals, will do well to work out the return under several methods, find out the reasons for the differing results, and make a final choice according to his own judgement.

A comparative study of evaluation of projects by the comparative cost, pay-back, return on investment, and discounted cash flow methods is illustrated below :

Project	Cash outflow (Capital cost)	Life of asset	Cash inflow (Return or income)					
			1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	Total
A	Rs. 50,000	5 yrs.	20,000	20,000	20,000	20,000	Nil	80,000
B	Rs. 50,000	2 yrs.	40,000	10,000	—	—	—	50,000
C	Rs. 50,000	5 yrs.	10,000	10,000	20,000	20,000	40,000	1,00,000

(i) *Comparative cost method*

All the three projects rank equal, the capital cost of each project being the same.

(ii) *Pay-back period*

A—3 years

B—2 years

C—4 years

Ranking is B A C

(iii) *Return on investment*

$$A : \frac{\text{Rs. } 80,000}{\text{Rs. } 50,000 \times 5} \times 100 = 32\%$$

$$B : \frac{\text{Rs. } 50,000}{\text{Rs. } 50,000 \times 2} \times 100 = 50\%$$

$$C : \frac{\text{Rs. } 1,00,000}{\text{Rs. } 50,000 \times 5} \times 100 = 40\%$$

Ranking is B C A

(iv) *Discounted cash flow method*

	Present value of return (Discount rate assumed is 5% per annum)		
	Project A	Project B	Project C
1st year	19,048	38,096	9,524
2nd year	18,140	9,070	9,070
3rd year	17,276	—	17,276
4th year	16,454	—	16,454
5th year	—	—	31,340
Total present value	70,918	47,166	83,664
Cost of project	50,000	50,000	50,000
Ranking is C A B	20,918	(—) 2,834	33,664

Another illustration of investment decision under the NPV method, when taxation is involved is given in the example below :

EXAMPLE 16.3.

A company desires to replace one of its plants that was acquired at a cost of Rs. 15,000 and the present market value of which is Rs. 16,250. The life of the plant is 8 years but it has to date been on commission for 3 years only. The company follows the reducing balance method of depreciation and the present book value of the plant depreciated at 37.5% per year is Rs. 3,662.

The plant proposed to be acquired would cost Rs. 30,000. It will have a life of 5 years so that the rate of depreciation under the existing method will be 60% per year. The salvage value of the plant at the end of its working life will be Rs. 750. The installation of the new plant will result in an increase of profit per year, before depreciation, over the existing amount of Rs. 60,000.

You are required to give your recommendation on the proposal, assuming the following :
 Rates of tax : On income, 50%; on capital gain, 40%
 Interest rate for discounting : 14% per annum

Discount factors at 14%

Year	1	2	3	4	5
Factor	.88	.77	.68	.59	.52

ANSWER :

Taxes will be worked out as follows .—

Capital gain :

Market value	Rs. 16,250	
Less Original cost	15,000	Tax
Capital gain	1,250	(40%) Rs. 500
Balancing charge :		
Sale proceeds	Rs 16,250	
Less Depreciated book value	3,662	
	Rs. 12,588	
Limited to depreciation allowed	Rs. 11,338	(50%) Rs 5,670
(Rs. 15,000—Rs. 3,662)		Rs. 6,170

Net outflow in year 0

Outlay	Rs. 30,000	
Less Net Sale proceeds	10,080	
(Rs 16,250—Rs. 6,170)		Rs. 19,920

Inflow : Years 1 to 5

Year	1	2	3	4	5	
	Rs.	Rs.	Rs.	Rs.	Rs.	
Gross Profit	60,000	60,000	60,000	60,000	60,000	
Less Depreciation	18,000	7,200	2,880	1,152	768	
	42,000	52,800	57,120	58,848	59,232	
Less Tax	21,000	26,400	28,560	29,424	29,616	
	21,000	26,400	28,560	29,424	29,616	
Add back Depreciation	18,000	7,200	2,880	1,152	768	
	39,000	33,600	31,440	30,576	30,384	
Salvage value					750	
					31,134	Total
Present value	34,320	25,872	21,379	18,040	16,190	1,15,801

The proposal for replacement is recommended.

5. *Annual cost method* : Under this method, the capital as well as the operating costs of alternative investment schemes are converted into equivalent annual costs at an assumed rate of interest.

The formula on Page 805 is, $P = E \cdot \frac{(1+r)^n - 1}{r(1+r)^n}$

Therefore, Annual cost, $E = P \cdot \frac{r(1+r)^n}{(1+r)^n - 1}$

Thus, an investment of Rs. 10,000 in an asset with no residual value at the end of its life of 4 years will represent, at 5% interest, an annual cost of :

$$\text{Rs. } 10,000 \times \frac{.05(1+.05)^4}{(1+.05)^4 - 1} = \text{Rs. } 2,821$$

When two or more investments are being compared, the one having the lowest annual cost is preferred. The assumed rate of interest is usually the rate at which the concern obtains its capital.

Where a company possesses a number of identical assets, the annual cost method may be used to determine the optimum economic life of each asset. Assets with a longer life have a lower average annual cost because the capital cost is spread over a longer period. On the other hand, with the passage of time the operating costs tend to rise. The optimum economic life of an asset would, therefore, be the stage where the sum total of the adjusted or equivalent annual cost and the operating cost is the minimum. We shall refer to this again in Chapter 19 in the discussion of replacement models.

The annual cost method is illustrated below:

EXAMPLE 16.4.

A company intending to purchase a new machine has the option to purchase either a new automatic machine at a cost of Rs. 1,00,000 or a general purpose machine which would serve the requirements, at a cost of Rs. 80,000. Both the machines have the same operative life of 5 years on the expiry of which period, the salvage values will be Rs. 10,000 and Rs. 5,000 respectively for the automatic and general purpose machines. The annual operating costs including labour, maintenance etc. of the general purpose machine is, however, twice that of the automatic machine, the annual operating cost of the latter being Rs. 20,000.

Assuming that the company's minimum rate of return is fixed at 15% per annum, which machine you would suggest should be purchased ?
(I.C.W.A., Final)

ANSWER :

For the automatic machine :

$$\text{Applying the formula, } E = P \times \frac{r(1+r)^n}{(1+r)^n - 1} = P / \frac{(1+r)^n - 1}{r(1+r)^n}$$

The equivalent annual cost of Rs. 1,00,000 at time 0, will be :

$$= \text{Rs. } 1,00,000 / \frac{(1+.15)^5 - 1}{0.15(1+.15)^5}$$

The value of $\frac{(1.15)^5 - 1}{0.15(1.15)^5}$ as calculated or obtained from tables is 3.352, so that the annual cost

$$= \text{Rs. } 1,00,000 / 3.352 = \text{Rs. } 29,830$$

The equivalent cost for the salvage value, Rs. 10,000 at time 5 can be found by applying the formula for the compound interest.

$$P = E \cdot \frac{(1+r)^n - 1}{r}, \text{ or } E = P / \frac{(1+r)^n - 1}{r} = \text{Rs. } 10,000 / \frac{(1.15)^5 - 1}{.15} = \text{Rs. } 10,000 / 6.7423 = \text{Rs. } 1,480$$

For the general purpose machine :

$$\text{Annual cost of Rs. } 80,000 = \text{Rs. } 80,000 / 3.352 = \text{Rs. } 23,870$$

$$\text{Annual cost of Rs. } 5,000 = \text{Rs. } 5,000 / 6.742 = \text{Rs. } 740$$

Comparative statement for the two machines will be :

	Automatic machine	General purpose machine
Per annum	Rs.	Rs.
Initial investment	29,830	23,870
Operating costs	20,000	40,000
Less Salvage value	1,480	740
Total annual cost	Rs. 48,350	Rs. 63,130

On the basis of the above, the decision will be to purchase the automatic machine since it has a lower equivalent annual cost.

6. *Profitability Index Method (or Desirability Factor Method).* The Profitability Index (PI) shows the relationship between the sum of discounted cash inflows and the sum of the discounted cash outflows, all cash inflows and outflows being discounted at a rate which is computed on the basis of cost of capital or the opportunity cost.

$$\text{Profitability Index} = \frac{\text{Sum of discounted cash inflows}}{\text{Sum of discounted outflows}}$$

With assumed data, profitability index for two projects may be calculated as follows :

	Project I Rs. (lakh)	Project II Rs. (lakh)
Initial cash outlay	2.00	1.50
Present Value of cash inflows	3.00	2.00
Net Present Value	1.00	0.50
Profitability Index (PI)	3.00/2.00 = 1.5	2.00/1.50 = 1.67

Like the NPV method, PI method helps in comparing projects of unequal size but in certain cases, the two methods give different results that lead to different conclusions. From the illustration given above, it will be seen that under PI method, Project II would be preferable because of its higher profitability index. NPV method however, gives a conflicting result because Project I would be more suitable due to its higher net present value. In course of time, higher net present value creates more wealth for the company and if the larger capital funds needed for Project I are available, that project will be selected. But in case of capital rationing when enough funds are not available, profitability index method will be more appropriate and Project II with higher PI will be the choice. It follows that when two mutually exclusive projects (i.e. those not dependent on one another) and requiring unequal initial investments yield the same amount of NPV, PI method will be more suitable and the project with higher PI will be selected.

Compared to the internal rate of return method, the profitability index method is superior under certain circumstances, besides its general advantage of simpler calculation without recourse to trial and error method. Being based on the cost of capital, PI is more realistic because it can be assumed that the inflow can be reinvested at the cost of capital. In the case of internal rate of return method, the assumption that the inflows can be re-invested at the IRR may be unrealistic, particularly if the IRR is high.

In decision making based on PI, consideration must also be given to the investment opportunities existing at the end of the useful life of the project. In case of projects with varying lives, a project with a shorter life but lower PI may be preferred only if there are good opportunities of re-investment after the expiry of the life of that project. If, however, the re-investment opportunities are not bright, a project with a longer life will be better even if the PI be lower.

In case of alternatives with different lives, computation of annualised net benefits of the respective cash flow of the mutually exclusive projects may be found useful. The annualised net benefit is worked out as follows and the project with higher benefit is selected.

$$\text{Annualised net benefit} = \frac{\text{Net present value of the project}}{\text{Present value factor of Rs. 1 at the end of the economic life of the project}}$$

Capital Rationing. Situations often arise in which, due to the operation of certain external or internal factors, a concern does not have nor can it obtain sufficient funds to meet the demands of all the proposed investments. In such cases, management has to resort to capital rationing, i.e. some investments have to be rejected although they meet the usual criteria of profitability or non-financial justification. For this purpose, some reasonable method of comparing the various alternatives and suitably ranking them has to be found out. One such method may be to rank all those investments which meet the profitability test in the order of their profitability. Investments proposed on the basis of non-financial considerations may also be similarly ranked on the basis of non-financial attractiveness. The latter ranking is, however, difficult and complicated due to the absence of any standard unit of measurement. When both the types of investments are ranked, it is almost impossible to inter-mix the two sets of ranking and this has to be left to the judgement of the management. Another method of ranking, though subjective but commonly used, is on the basis of priority of the projects. The best method, however, would be to use linear programming technique.

Capital Investment and Inflation. In the present context of continual inflationary tendencies in the country, the point of particular importance in investment decisions is that the purchasing power of the return declines as the price level rises. Thus, if an investment yields a return of Rs. 100 this year and Rs. 100 next year and if the price index changes from 100 this year to 105 next year, the purchasing power of Rs. 100 to be received next year will be only Rs. $100/1.05$ = Rs. 95.24. While calculating the present value of the next year's return, the discount rate should, therefore, be applied on Rs. 95.24 and not on Rs. 100.

Plant Replacement Projects. Plant replacement is essentially a problem of timing. All plants have a life period during which they are capable of working efficiently if properly maintained. Regular maintenance and repairs may perhaps prolong the working life of a plant but a time is reached when it is no longer economic to run it; the cost of operation would at this stage, exceed the cost of replacement. There is no choice but to discard the asset and replace it by another. The problem involved is mainly to select from amongst the various alternative replacements available. However, it often becomes necessary to replace obsolete plants or to modernise an old model plant even before the expiry of its life and a decision is required to be taken whether to continue to work with the existing plant or to replace it. A large number of factors are to be considered before a final choice is made, more important of which are the rate of return on investment and the cost per unit of the output. The following points are to be kept in view :—

- (i) Difference in operating cost, after taking depreciation into account. (Cost per unit of production on working with the new plant vis-a-vis that with the old plant.)
- (ii) Nature of the product, e.g. whether it is likely to become obsolete in the near future in which case, there is no need for replacing the plant, if it is a special purpose plant for the product.
- (iii) Risk of obsolescence of the new plant—whether technological improvements in the proposed plant are in the offing, in which case it may be advisable to wait till a new model comes up in the market.

- (iv) Increase in volume vis-a-vis demand—whether the market will be able to absorb increased production.
- (v) Comparative profitability, and rates of return and interest on capital.
- (vi) Key factors and resource constraints, if any, should be considered.
- (vii) Assessment of opportunity cost, i.e. whether or not the funds for the proposed investment could be more gainfully employed elsewhere.
- (viii) Effect on inventory accumulation.
- (ix) Trend of the market for capital goods—whether the current purchase price is favourable or whether a fall is shortly expected.
- (x) Whether the new asset is likely to create any bottleneck or any unbalanced capacity.
- (xi) The disposal value of the existing plant should be taken as a reduction from the investment on replacement.
- (xii) Additional capital expenditure to be incurred on related projects such as those for welfare and amenities, which do not yield a return.
- (xiii) Government policy such as those regarding changes in excise duty and import duty affecting the cost of the material which will be processed through the proposed plant.
- (xiv) Likelihood of substitute product at a relatively low cost coming up in the market.

A few examples are given below to illustrate the evaluation of a project when plant replacement is being considered.

EXAMPLE 16.5.

Messers Bharat Industries Ltd. purchased a machine five years ago. A proposal is under consideration to replace it by a new machine. The life of the machine is estimated to be 10 years. The existing machine can be sold at its written down value. As the Cost Accountant of the company, you are required to submit your recommendations based on the following information :

		Existing machine Rs.		New machine
Initial cost		25,000		50,000
Machine hours per annum	2,000		2,000	
Wages per running hour		1.25		1.25
Power per hour		0.50		2.00
Indirect materials per annum		3,000		5,000
Other expenses per annum		12,000		15,000
Cost of materials per unit		1		1
Number of units produced per hour	12		18	
Selling price per unit		2		2
Interest to be paid at 10% on fresh capital invested.				(I.C.W.A., Final)

ANSWER :

	Existing Machine	New Machine
Units produced per annum	24,000	36,000
Selling price per unit	Rs. 2.00	Rs. 2.00
Sales	Rs. 48,000	Rs. 72,000

Cost		
Wages	2,500	2,500
Power	1,000	4,000
Indirect materials	3,000	5,000
Other expenses	12,000	15,000
Cost of materials	24,000	36,000
Depreciation	2,500	5,000
Interest	—	3,750
	<hr/> Rs. 45,000	<hr/> Rs. 71,250
Profit	Rs. 3,000	Rs. 750
Cost per unit	Rs. 1.87	Rs. 1.98
Profit per unit	Re. 0.13	Re. 0.02

On the basis of the above information, the choice will be for the existing machine to continue. A further analysis as shown below will also strengthen this view.

Profit with new machine before charging interest = Rs. 750 + Rs. 3,750 = Rs. 4,500

Incremental profit = Rs. 4,500 - Rs. 3,000 = Rs. 1,500

Average investment = Rs. 36,000/2 = Rs. 18,000

Return = $\frac{\text{Rs. 1,500}}{\text{Rs. 18,000}} = 8.33\%$ (before interest payment)

This is not enough to pay even the interest at 10% on the fresh capital invested.

EXAMPLE 16.6.

A cigarette manufacturer proposes to replace his existing cigarette making machines, which produce at the rate of 1,200 cigarettes per minute, by the latest type of high-speed machines that operate at the rate of 2,000 cigarettes per minute.

The existing machines cost £6,000 each, ten years ago. New and old machines have an estimated total useful life of 20 years. The depreciation provision is by the "Straight-line" method, the residual value for each machine being £1,000. The price of the new machine is £10,000. The present part-exchange value of the existing machines is £1,500 each.

The new machine will occupy only 80% of the effective floor space of an old machine the cost of which is £50 per year.

The following details also apply :

	Old machine	New machine
Annual operating hours	1,500	1,500
Operator's annual wages	£ 550	£ 550
Annual repair and maintenance cost	£ 150	£ 190
Annual power cost	£ 50	£ 110

Any probable capital loss on the old machines is to be included in the estimated costs of the new machines.

- Tabulate a comparative cost estimate for one year of an old and a new machines.
- Calculate how many cigarettes must be produced by the new machine to yield savings equal to the extra capital outlay it involves. (Ignore tax). (I.C.M.A., Final)

ANSWER :

Comparative information for the old and new machines :

	Old machine	New machine
Cost	£6,000	£10,000
Book value	£3,500	—
Exchange value	£1,500	—
Life	20 yrs.	20 yrs.
Production per year	108,000,000 (1,200 × 1,500 × 60)	180,000,000 (2,000 × 1,500 × 60)
Depreciation	£250 [(£6,000 - £1,000) ÷ 20]	£450 [(£10,000 - £1,000) ÷ 20]

(a) Annual cost estimate :

	Old machine £	New machine £	
Operating wages	550	550	
Repairs and maintenance	150	190	
Power	50	110	
Floor space	50	40	(80% of £50, assuming that the rest of the space is suitably utilized)
Loss on sale of old machine		100	(loss spread over 20 years)
Depreciation	250	450	
	£1,050	£1,440	
Units produced	108,000,000	180,000,000	
Cost per million cigarettes	£9.72	£8	
Saving per million = £1.72 with the new machine			

(b) Extra capital outlay = £10,000 - £1,500 = £8,500

Quantity of cigarettes to be produced to yield savings equal to capital outlay :

$$\frac{£8,500}{£1.72} = 4,942 \text{ million}$$

EXAMPLE 16.7.

A computer is available at a cash purchase price of Rs. 4,40,000. If taken on hire, the charges would be Rs. 15,400 per month for a minimum base of 36 months, and thereafter the rate would be reduced to Rs. 7,500 per month. The rentals fall due for payment at the end of each month.

A company planning to acquire the above computer wants advice whether it would be more economical to purchase the machine or take it on hire. What would be your advice if the cost of capital is to be taken as 10% per annum? The present values of Re. 1 and Re. 1/12 paid monthly, at the end of n years both at 10% are as follows :—

After year (n)	Present value of Re. 1/12, paid monthly	Present value of Re. 1
1	0.950	0.909
2	0.864	0.826
3	0.785	0.751
4	0.714	0.683
5	0.649	0.621
6	0.591	0.564

(I.C.W.A., Final—Adapted)

ANSWER :

Year	1 Rs.	2 Rs.	3 Rs.	4 Rs.	5 Rs.	6 Rs.
<i>Purchase of machine</i>						
<i>Cash flow :</i>						
Beginning of year	4,40,000					
End of year	44,000	44,000	44,000	44,000	44,000	44,000
Discount factor	0.909	0.826	0.751	0.683	0.621	0.564
Present value of cash flow	4,40,000					
	+ 39,996	36,344	33,044	30,052	27,324	24,816
Cumulative present value (a)	4,79,996	5,16,340	5,49,384	5,79,436	6,06,760	6,31,576

Years	1 Rs	2 Rs.	3 Rs	4 Rs.	5 Rs	6 Rs
<i>Hiring of machine</i>						
Cash flow	1,84,800	1,84,800	1,84,800	90,000	90,000	90,000
Discount factor	0.950	0.864	0.785	0.714	0.649	0.591
Present value of cash flow	1,75,560	1,59,667	1,45,068	64,260	58,410	53,190
Cumulative present value (b)	1,75,560	3,35,227	4,80,295	5,44,555	6,02,965	6,56,155
Difference (a - b)	3,04,436	1,81,113	69,089	34,881	3,795	(24,579)

The above analysis shows that the difference in the cash outflow gradually decreases from year to year. In the fifth year, the difference is not significant and if the computer is not expected to be obsolete till then or has still some life to run over a number of more years, it would be advisable to go in for purchase. In the sixth year, the cumulative cash outflow on hiring is more than on purchase and this difference would be more if the disposal value of the purchased computer is taken into account.

EXAMPLE 16.8

Due to financial failure of an overseas competitor, a company sees the opportunity of taking up immediately a market for its product of 325,000 tonnes per annum which is forecast to rise at 9% per annum. Sales revenue is expected to be £8 per tonne ex plant.

The company proposes to go into this market immediately and considers methods of supply involving the import from elsewhere, the hiring of plant locally, and the construction of new plant. Details are as follows:

*Import from elsewhere

It could import up to a maximum of 500,000 tonnes per annum of the product at an average cost of £7.5 per tonne at the plant.

*Hire of plant locally

It could hire plant capacity of 500,000 tonnes per annum at a nearby site. This is available immediately.

The terms of hiring are £1.2 per tonne of capacity, a minimum of 12 years, with the plant owner being responsible for any variable operating cost. Direct material costs of £6 per tonne would be payable by the company.

*Construction of new plant

It could build a plant with an effective capacity of 500,000 tonnes per annum which will be completed in three years. In the meantime, requirements may be imported.

Capital expenditure will be £1.75 million spent at the end of each year, as follows:

June 1980	£0.30 million
1981	£0.45 million
1982	£1.00 million

The expected life of the plant is 12 years and its salvage value is expected to be £0.3 million.

Direct material costs are expected to be £6 per tonne, variable operating costs £0.3 per tonne, and fixed operating costs £100,000 per annum.

The company requires a cut-off rate of 20% DCF for projects involving capital expenditure.

You are required to recommend what action the company should take to achieve its objective. Support your recommendation with relevant calculations.

Ignore taxation and inflation considerations.

(ICMA Pt III)

ANSWER :

Alternative 1 : Import from elsewhere

No capital expenditure is involved. The margin will be

	Per tonne £
Selling price	8.00
Import cost	7.50
Margin	0.50

Alternative 2 : Hire of plant locally

This also does not involve any capital expenditure. For the purpose of comparison with alternative 3, we shall consider the cash flow for 15 years, i.e. 12 years of the contractual commitment with the plant owner and 3 years of the pre-production stage in alternative 3.

The annual cash outflow for meeting the capacity cost @ £1.2 per tonne will be 500,000 tonnes \times £1.2 = £600,000.

The advantage of alternative 2 over alternative 1 can be seen from the following table :

Year	Tonnes*	Advantage Margin**	Capacity Cost	Net Advantage		Net Present Value
		£	£	£	***	£
1	325,000	487,500	600,000	(-) 112,500	.83	(-) 93,375
2	354,250	531,375	600,000	() 68,625	.69	() 47,351
3	386,133	579,200	600,000	() 20,800	.58	() 12,064
4	420,884	631,326	600,000	31,326	.48	15,036
5	458,764	688,146	600,000	88,146	.40	35,328
6-15	500,000	750,000	600,000	150,000	1.69	253,500
						<u>151,074</u>

*The present market for 325,000 tonnes per annum rises at the rate of 9% per annum and reaches in 6 years to the maximum of 500,000 tonnes per year.

**The marginal advantage of alternative 2 over alternative 1 is £1.50 per tonne, arrived as follows :

Selling price	£8.00
Material cost	£6.00
	— — —
Margin	£2.00
Margin (Alt. 1)	£0.50
	— — —
Advantage (Alt. 2)	* £1.50

***Discount factor (obtained from tables) at cut off rate of 20%. Since the capital expenditure in respect of the new plant will be incurred at the end of each year, it is assumed that cash flow in respect of all the alternatives will commence at year 1.

It will thus be seen that alternative 2 offers an advantage of £0.15 million over alternative 1. However, this envisages a long-term commitment under capacity contract, making alternative 2 less flexible.

Alternative 3 : Construction of new plant

In this alternative, requirements for the first three years will be imported and production will start only from the year 4.

The cash flow for 15 years will be projected as follows ; as compared with alternative 2 .

Year	Tonnes	Differential cost*	Capacity cost saved	Net saving		Net present
		£	£	£		£
1	325,000	487,500	600,000	112,500	.83	93,375
2	354,250	531,375	600,000	68,625	.69	47,351
3	386,133	579,200	600,000	20,800	.58	12,064
4	420,884	226,265	600,000	373,735	.48	179,393
5	458,764	237,629	600,000	362,371	.40	144,948
6-15	500,000	250,000	600,000	350,000	1.69	591,500
						<u>1,068,631</u>

Present value of benefits from alternative 3 over alternative 2

(i) *For years 1, 2 and 3 :

Import cost	£7.50
Less Material cost alternative 2	£6.00
	— — —
Excess import cost	£1.50 per tonne

(ii) For years 4 to 15 :

Each year—£100,000 + £0.3 per tonne,

Plant costs :				1,068,631
Year	£		£	
1	300,000	.83	249,000	
2	450,000	.69	310,500	
3	1,000,000	.58	580,000	
			<hr/>	
			1,139,500	
15	300,000	.06	18,000	(—)
			<hr/>	
				1,121,500
				<hr/>
				(-) 52,869

Thus alternative 3 would result in a deficit of £0.05 million over alternative 2.

The final conclusion is that of the three alternatives, alternative 2 is preferable provided the anticipated market growth materialises.

Sensitivity Analysis. Sensitivity Analysis is a method of systematically determining the effect which different values of decision parameters (i.e., the key variables in a decision model) will have on the decision criteria (i.e., the ultimate expected output). In building up a decision model, estimates are made of the various relevant factors, all of which are subject to variations and each such variation will have an impact on the final expected outcome of the decision. For instance, in the context of a capital investment decision, a project is evaluated on the basis of estimates of a number of key variables such as, (i) initial cost, life and salvage value of the capital asset, (ii) revenue in terms of sales volume and selling price, and (iii) the costs of operation involved, classified under labour, material, overhead etc. When any one or more of these factors vary, e.g. if selling price goes down or the cost of operation goes up or capital expenditure goes down and so on, each variation will affect the expected internal rate of return or the net present value of the project. The impact of each variation will, however, be different and certain of the estimated factors would be more sensitive to the variation than others. If a small change in the parameter value (say, a small reduction in the selling price) has a large effect on the model output (say, a significant or sharp decrease in the expected internal rate of return), the project would be most vulnerable to that parameter value, viz. the reduction in price. By bringing out the effects of each variation on the output, the method of sensitivity analysis determines the answer to 'what if' problems (e.g. what happens if selling price is reduced) and assists the management in judging the impacts of all possible variations and taking proper care of the sensitive areas.

In a practical situation, a decision problem would usually consist of innumerable key variables built into a complex mathematical model. The present day access to computer facilities, however, makes sensitivity analysis a simple affair regardless of the complexity of the problem. The estimated values of the variables are allowed to vary within a relevant range of possibilities and the effects on the output model are determined. From the information thus obtained, sensitivity analysis is able to pin-point sensitive or weak areas so that the management can pick up the thread and concentrate attention on these factors leaving out those which are lower down in the sensitivity ranking. It should be noted that sensitivity analysis does not itself solve any problem and its function ends with the presentation of the sensitivity ranking of the various factors.

To illustrate the basic method of sensitivity analysis, a simple example is given below :

EXAMPLE 16.9.

The following data in respect of a proposed project are given :—

Capital Cost	Rs. 25 lakh
Life	10 years
Salvage Value	Rs. 2.5 lakh
Operating details :	
Volume of sales	10,000 units per annum
Selling price	Rs. 200 per unit
	<i>Per annum</i>
Sales Revenue	Rs. 20 lakh
<hr/>	
Labour cost (10,000 units × Rs. 20)	Rs. 2 lakh
Material cost (Rs. 60 per unit)	6 lakh
Variable overhead (Rs. 40 per unit)	4 lakh
Fixed cost	3 lakh
Cash inflow	5 lakh

Internal Rate of Return 15.7%

It is anticipated that some of the key variables are likely to vary to the extent shown below :

- Reduction of 10% in selling price ;
- Decrease of 10% in volume of sales ;
- Increase of 10% in fixed cost ;
- Increase of 10% in capital cost ; no change in salvage value

Taking each of the above factors separately, compute their impact on the projected internal rate of return and rank them according to their sensitivity.

What recommendations would you make to the management ?

ANSWER :

Working details .

(i) A 10% reduction in selling price will have the effect of reducing the annual cash inflow to Rs. 3 lakh (Rs. 5 lakh *minus* 10% of Rs. 20 lakh)

(ii) Decrease of 10% in sales volume will result in :

Sales (9,000 units × Rs. 200) Rs. 18.00 lakh

Variable cost (9,000 units × Rs. 120) Rs. 10.80 lakh

Fixed cost 3.00 lakh

Annual cash inflow Rs. 4.20 lakh

(iii) Increase in fixed cost by 10%, i.e. Rs. 30,000 per annum will reduce the annual cash inflow to Rs. 4.70 lakh (Rs. 5 lakh *minus* Rs. 30,000)

(iv) Increase in the capital cost affects the cash outflow and it has no effect on the cash inflow.

With the help of the above data, the following chart may be constructed and the internal rate of return for each possibility computed from tables :

	Original Estimate	Variation (i)	Variation (ii)	Variation (iii)	Variation (iv)
	Rs. (Lakh)	Rs. (Lakh)	Rs. (Lakh)	Rs. (Lakh)	Rs. (Lakh)
Yr. 0	(-) 25.00	(-) 25.00	(-) 25.00	(-) 25.00	(-) 27.50
Yr. 1—10	5.00	3.00	4.20	4.70	5.00
plus					
Yr. 10	2.50	2.50	2.50	2.50	2.50
IRR	15.7%	4.8%	11.3%	14.2%	13.1%

Ranking according to sensitivity :

	IRR
1. Selling price	4.8%
2. Sales volume	11.3%
3. Capital cost	13.1%
4. Fixed cost	14.2%

The management will be advised to pay prior attention to the problem of selling price and proceed to find answers to the following probable questions :

1. What would be the probability of price reduction happening ;
2. Whether the reduction can be halted through any remedial measures ,
3. If changes of price reduction are high and control over price is not possible, whether it would be prudent to discard the proposed project and seek for an alternative?

Cost of Capital. Since the cost of acquiring capital varies according to the source from which it is obtained, the acceptance of an investment proposal also depends upon the manner and source of its financing. We have seen that a proposal is accepted, if (i) its net present value is more than the cash flow discounted at a rate which is the cost of capital (expressed as a rate) or (ii) its internal rate of return is more than the cost of capital. Putting it the other way, we can say that cost of capital is the required rate of return that would justify the use of the capital.

Determination of cost of capital is a topic which should appropriately find place in a text book on financial management. However, because of its importance in the context of investment decision making, mention has been made here of the common methods used for measuring the cost of capital obtained from various sources.

Cost of debt and preference shares may be taken as (i) the specified rate of interest or dividend, or (ii) a projected rate based on the historical trend and taking into account future likely factors influencing interest or yield rates, or (iii) a rate based on market price. If, for example, the average market price over a number of years of a 8% debenture issue of nominal value Rs. 100 be Rs. 94.

average cost, under the last method, will be $\frac{100}{94} \times 8 = 85.1\%$.

Cost of equity may be taken as (i) the dividend paid or payable, or (ii) the average earning, per share. The rate may be computed as a percentage of its face value or market value or the net realisable value of the proposed issue, thus :

Let us assume that,

Existing equity, face value	Rs. 100 each
Market value	1st year Rs. 95
	2nd year Rs. 102
	3rd year - Rs. 115
Proposed fresh issue of equity, face value	Rs. 120 each
net realisable value -	Rs. 118 each
(cost of issue	Rs. 2 per share)

Dividend and earning per share for the last three years were

Year	Dividend Rs.	Earning Rs.
1	10	10
2	10	15
3	12	18

Based on the above figures, the cost of equity will be computed as follows :—

On the basis of dividend expressed as percentage of :

	Face value	Market value	Net realisable value of new issue
1st year	$10 \left[\frac{10}{100} \times 100 \right]$	$10.5 \left[\frac{10}{95} \times 100 \right]$	$8.5 \left[\frac{10}{118} \times 100 \right]$
2nd year	10	9.8	8.5
3rd year	12	10.4	10.2
Average	10.67	10.2	9.1

Similar computation may be made with the figures of average earning per share, viz. Rs. 10, Rs. 15, Rs. 18 for the first, second and third years respectively.

Cost of retained earnings is taken as equal to (i) cost of equity capital, or (ii) cost of equity reduced by the tax payable by the average shareholder on the dividend received by him.

The source of funds employed by a concern varies from time to time depending upon a large number of factors. According to the situation obtaining at the point of time, one investment proposal may be financed from one source such as by borrowing and another investment from a different source, say, by the use of internal funds. While measuring the cost of capital, however, it would not be appropriate to relate specific investments with specific source of funds. The employment of a particular method of financing has an impact on the business capital mix of the company. For investment decisions, therefore, the concern should be viewed as an integral unit, and funds, though obtained or proposed to be obtained from a particular source, should be deemed as drawn from the general pool consisting of all types of funds. For this purpose, the cost of capital should be computed as the *weighted average* of the costs of the various types of capital acquired by the company. The basis adopted for working out the average may be (i) the existing capital structure (face value), or (ii) the market value of the existing capital, or (iii) the future anticipated capital structure, or (iv) ideal capital structure. For example, if in a company the capital structure and the imputed costs of each type of capital be as follows :

<i>Capital resources</i>		<i>Imputed cost</i>
Equity	Rs. 1,50,000	11%
Preference shares	Rs. 50,000	10%
Debt	Rs. 2,00,000	10%
Retained earnings	Rs. 3,00,000	8%
Depreciation	Rs. 3,00,000	6%
	<hr/> Rs. 10,00,000	

the weighted average cost of capital will be :

$$\frac{(1,50,000 \times 0.11) + (50,000 \times 0.1) + (2,00,000 \times 0.1) + (3,00,000 \times 0.08) + (3,00,000 \times 0.06)}{10,00,000} = \frac{83,500}{10,00,000} = 8.35\%$$

An example to illustrate the calculation of composite cost of capital is given below.

EXAMPLE 16.10.

For varying levels of debt equity mix, the estimates of the costs of debt and equity capital (after tax) are given overleaf.

Debt as percentage of total capital employed	Cost of debt %	Cost of equity %
0	7.0	15.0
10	7.0	15.0
20	7.0	16.0
30	8.0	17.0
40	9.0	18.0
50	10.0	21.0
60	11.0	24.0

You are required to decide on the optimal debt-equity mix for the Company by calculating the composite cost of capital.
(I.C.W.A., Final)

ANSWER :

Optimal debt equity mix will be a combination that has the minimum composite cost of capital. The composite cost will be :

Cost of debt \times proportion of debt on total value + cost of equity \times proportion of equity on total value.

The relevant data are tabulated as follows :

Cost of debt %	Cost of equity	Proportion of debt on total value	Proportion of equity on total value	Composite cost %
d	e	w_1	w_2	$d \times w_1 + e \times w_2$
(1)	(2)	(3)	(4)	(5)
				$(1 \times 3 + 2 \times 4)$
7.0	15.0	0.0	1.0	15.00
7.0	15.0	0.1	0.9	14.20
7.0	16.0	0.2	0.8	14.20
8.0	17.0	0.3	0.7	14.30
9.0	18.0	0.4	0.6	14.40
10.0	21.0	0.5	0.5	15.50
11.0	24.0	0.6	0.4	16.20

It will be seen from the above table that there are two options of debt-equity mix that are optimal, viz. (i) 10% Debt and 90% equity or (ii) 20% Debt and 80% equity.

Control of Capital Expenditure. The reasons why capital expenditure merits special consideration were discussed earlier. A comprehensive and progressive system of capital expenditure control is an important element of successful company development. Because of the importance of capital expenditure, control and review of the merits of a project are made on three occasions, viz. at the capital budgeting stage, while making request for appropriation of funds, and finally when the project is completed. Although the last mentioned review may be too late to correct any error in the project plan under investigation, particularly in small projects which have not been phased over a number of years, it is helpful in assessing future projects of further work packages of the same big project.

The objectives of control of capital expenditure are :

- To assess cash outlay for capital expenditure that would fit in the overall financial plan of the business, and to ensure that cash will be forthcoming as per schedule, for short-term and long-term projects and development plans.

- (b) To co-ordinate policy in order to achieve balance among purchases of capital assets, and to ensure that the requirements of the different units are in accordance with the overall policy.
- (c) To ensure that no expenditure is incurred without proper sanction.
- (d) Allocation of funds to the best of the several alternative schemes, i.e. to the most profitable projects.
- (e) Fixation of the order of priorities of the various projects to be undertaken.
- (f) Periodical comparison between authorised and actual capital expenditure so as to obviate any excess expenditure, before its incidence.
- (g) To compare the results when a project is computed in order to see whether they agree with the plan.
- (h) The control plan not only looks after the economic spending but also ensures that enough funds are spent on plant and equipment so that the concern keeps pace with the industry by producing quality products at competitive costs.

The various steps involved in the control of capital expenditure are :

1. Authorisation of expenditure through (a) capital expenditure budgets and (b) sanction of appropriations requests.
2. Reporting and control of expenditure.
3. Assessment on completion of the project through follow up of the return from investment.

1 *Authorisation of capital expenditure* : The first step in the control of capital expenditure is to set a capital budget. The procedure for the preparation of capital expenditure budget was discussed in Chapter 11. Capital expenditure is provided for in the capital expenditure budget and also incorporated in the cash budget. The total amount included in the capital budget is established by one of the following methods :—

- (i) By deciding upon the maximum amount available for capital expenditure. This decision is taken at a high level and efforts are made to ensure that the overall capital budget is established within this maximum figure.
- (ii) By aggregating the various capital expenditure proposals to arrive at the budgeted amount.

Provision of funds for a particular project in the budget does not in itself constitute an authority to go ahead with the programme. While the budget approves the future expenditure in principle, a further authorisation is necessary for undertaking the work and for incurring expenditure. A request for approval of the amount is made and sanction would be given only after a second review has been made to see that the project, as originally approved in the capital budget, is still justifiable under current conditions.

As a rule, no capital expenditure should be incurred without proper sanction. The procedure for authorising capital expenditure varies with regard to the size and type of the organisation but the following general principles may be laid down :—

- (i) Authority for sanctioning expenditure should be delegated to the various levels of executives. While major projects may be sanctioned by the Board of Directors, minor projects and small capital expenditure of a routine nature may be sanctioned by the senior executives. Financial limits are generally laid down

up to which various executives are empowered to sanction capital expenditure. This procedure guards against improper or imprudent sanctions of heavy amounts by the lower authorities.

(ii) All sanctions should be asked for and given on standard forms suitably designed to meet the needs of the individual business. While no standard form for appropriations, requests and authorisation suitable for all organisations can be given, a specimen form is shown in Fig 16.2. The form contains all relevant information like necessity (or justification) for the proposed expenditure, initial cash outlay, life of the asset, expected running cost of plant and machinery, effect on product costs, anticipated savings, profitability, estimated cash flow, etc. The authorisation form is filled up by a responsible executive and put up to the proper authority for approval. The approval or rejection of the proposal is recorded on the form.

CAPITAL PROJECT REQUEST AND AUTHORIZATION			
Department	Project classification		No.
Division	Replacem ^t	Addn Alteration	Date
Life of project	Buildin ^g	Plant Equipmen ^t	
Reasons			Date comm ^{encement}
Other details and appraisal			Date completion
Estimated return			Estimated expenditure
Foreign Exchange saving			Signature
AUTHORIZATION			
		Approved	Rejected
Decision of Budget Committee	Decision of Board		
Signature No.	Signature		
Amount authorised	Date		

Fig 16.2 Capital Project Authorisation

(iii) The cost accountant submits his project evaluation report indicating besides profitability all other relevant factors which include the cash position, additional working capital required and details of other projects sanctioned during the period so as to assist the sanctioning authority in fixing priority for the various projects put up for sanction.

(iv) All requests for appropriations are routed through the budget committee to ensure that budget provisions exist for the proposed expenditure. In special cases, non-budgeted funds may be authorised in one of the following ways:

- Providing additional funds.
- Reappropriation by cutting down some other project of less importance or lower priority.
- Making provision of an amount in the original budget to meet such contingencies.
- Capital works which are to be executed internally with own labour and material usually involve small expenditure. These are sanctioned by lower executives on capital work orders.

If the actual physical performance of the project is not the same as the budgeted physical target for the period, comparison of the actual costs with the sanctioned amount will not bring out the real variance. For this purpose, the total budgeted amount for the period should be adjusted in the ratio of the actual physical performance to the budgeted physical target. For instance, if during a year, 50% of the project is expected to be completed and for which an amount of Rs. 10 lakhs is sanctioned, the adjusted budget for an actual physical achievement

the period will thus be compared with Rs. 4 lakhs (and not Rs. 10 lakhs) for the purpose of calculation of the variance.

Plant and Machinery Register. (Also known as *Capital Assets Register*, *Plant ledger*, *Capital Block Ledger*, or *Property Ledger* depending upon the nature of the capital asset for which the register is maintained.) This register records full particulars of the assets such as name, specification, and number allotted to the asset, its purchase price, rate and amount of depreciation charges in each period, cost of additions and disposal, and the depreciated book values at the beginning and end of each period. A form of plant and machinery register is given in Fig. 16.4.

[illegible]

Fig. 16.4. Plant Register

Note : The register may be so designed as to record entries for several years. In the form illustrated above, rulings for two years have been given.

In this form, the amount of depreciation to be charged against each asset is entered in the register itself. In another type of plant and machinery register or ledger (see Fig. 16.5), only the method and rate of depreciation are indicated; the actual amount of depreciation is worked out and recorded separately in a *Depreciation Schedule* (Fig. 16.6). The form in Fig. 16.5 provides for columns for recording details of maintenance. This information may also be suitably included in the form shown in Fig. 16.4.

The plant and machinery register may be either in the loose leaf form or in the form of bound volumes, and entries in the register may be made manually or mechanically under the punched card or any other machine accounting system. Separate registers may be maintained for each type of asset, viz. for plant, machinery, buildings, etc.

PLANT LEDGER					
Name of asset :			Ledger sheet no		
Specification :			Department :		
No. :			Method of depreciation :		
Make and suppliers :			Rate of depreciation :		
Date of purchase :			Cost of purchase (including erection cost) :		
Estimated life :			Estimated salvage value :		
Details of maintenance					
Date	Service order number	Cost	Date	Service order number	Cost

Fig 16.5. Plant Ledger

Plant and machinery register serves the following purposes :-

- (i) It provides a ready permanent historical record of all capital assets, their disposal, and periodical additions.
- (ii) It provides a basis for calculation and charging of depreciation correctly.
- (iii) It assists in the planning and control of capital expenditure by providing suitable data for preparation of capital expenditure budget.
- (iv) It provides proved statistics for income tax claims for depreciation and development rebates. Suitable data are also provided for property insurance.
- (v) It provides ready means to locate surplus assets with a view to their disposal.
- (vi) Data are readily available for submission to the Government or to trade associations, whenever required.
- (vii) It provides for control of maintenance costs.

[illegible]

Fig. 16.6. Depreciation Schedule

3. *Assessment on completion of the project through follow-up of the return from the investment* : The final phase in the control of capital expenditure consists of a post completion audit. This is a follow-up procedure for determining whether the saving actually realised from a project compares favourably with the return which was anticipated at the time of making a request for the investment.

A report is made on the completion of a project. The report provides a comparison of the actual expenditure with the estimated expenditure as set forth in the original request for appropriation. In case of long-term projects, the reports may be prepared at intervals, say annually, even before completion of the project. Such reports would indicate the progress made toward completion of the project, the extent of work still to be completed, the likely further expenditure for completion, and the probable date of completion if the scheduled date is not anticipated to be kept.

The *objectives* of the follow-up procedure are as follows : -

- (i) When a project fails to yield the anticipated return, further action may be taken to improve the position so that the planned performance is achieved.
- (ii) The follow-up curbs tendency on the part of the executives to put tall claims and overstate the savings likely from particular projects which they are pressing for acceptance.
- (iii) Future requests for similar investments may be adjusted on sound lines.

Practice varies as to the department which is entrusted with the responsibility for the review. Usually, the cost accountant or the internal auditor is in a better position to perform the follow-up work. The engineering department or the works manager may also be asked to evaluate the technical aspects of the project based on which the savings were originally anticipated.

RETURN ON CAPITAL EMPLOYED

The *return on capital employed* is the management's analytical tool for the control of capital expenditure. It measures the effectiveness of the past operations and is a useful guide in planning for future business. The determination of the return and fixing up a yardstick, or some sort of standard, against which the achievement can be compared become imperative for the purpose of finding out how effectively the capital has been employed and for measuring the extent of productivity of the proposed capital expenditure on a new project or on a scheme of change.

It is common practice to consider the profitability of a concern in terms of profit in relation to the turnover. The ratio, profit to sales, provides a very handy measure for judging performance for the purpose of internal control in a business but this cannot be used as the sole measure of profitability. When heavy capital investment is made to achieve a higher turnover, the resulting higher profit, when expressed as a percentage of capital employed, would show a considerably lower figure. As will be seen from the example given below, although increased investment may result in more sales, lower cost of production, and higher profits, the return on the capital employed may not be adequate enough to justify the investment made :

	A (Existing)	B (Proposed)
Capital employed	Rs. 20,000	Rs. 50,000
Sales	Rs. 10,000	Rs. 12,000
Costs	Rs. 8,000	Rs. 9,000
Profit	Rs. 2,000	Rs. 3,000
Profit/Sales (%)	20	25
Profit/Capital Employed (%)	10	6

In order to measure the real overall success of the organisation, it is, therefore, essential to determine the return on capital employed.

The return on capital is dependent upon two factors, viz. (i) profit to turnover, and (ii) turnover on capital employed.

$$\begin{aligned} \text{Return of Capital} &= \frac{\text{Profit}}{\text{Capital employed}} = \frac{\text{Profit}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Capital employed}} \\ &= \frac{\text{Profit}}{\text{Sales}} \times \text{Rate of turnover of capital} \end{aligned}$$

A good deal of controversy and differences of opinion have arisen as to what is profit and what is capital employed and what are the items which may be appropriately included under the two heads. The problems as to what should be the yardstick, i.e. what should constitute an adequate return on capital, presents another difficulty.

Capital Employed. For the purpose of constituting a base for computation of the return on capital, the capital employed is broadly represented by :

<i>Fixed Assets</i>	<i>Current Assets</i>
Land	Cash
Building	Sundry debtors
Plant and machinery	Stock of
Equipments	(i) Raw materials and stores
	(ii) Work-in-progress, and
	(iii) Finished goods.

The above gives the gross capital employed but some accountants are of the view that current liabilities should be deducted so as to arrive at what they call the net capital employed. The following items are, however, not included in the capital employed for the purpose of determining the return : --

Idle capital
Investment outside the business
Investment in safety, welfare, and prestige measures
Intangible and fictitious assets
Surplus Cash or Bank balance

Fixed assets may be taken at (i) Original cost, (ii) Net value or (iii) Replacement cost.

(i) *Original cost* : Valuation of assets on the original cost basis for the determination of the return on capital has the following features :—

- As original cost is not liable to change, it offers a uniform and steady base for the purpose of comparing profits and results of different periods.
- As depreciation is not taken into account, any errors in computing depreciation cannot distort results.
- Inter-firm comparison of the return on capital can easily be made even if the assets in the individual firms are purchased in different periods.

(ii) *Net value* : This is the depreciated book value as exhibited in the Balance Sheet. The particular features of this method of valuation of assets for determining the return on capital are :

- The net value represents the actual figure as per the books.
- The figures are in accordance with those in the Balance Sheet.
- The method is in agreement with the concept that the earning capacity of an asset decreases with its continued use and passage of time. (The decrease in earning capacity is, however, slower than the rate of depreciation.)
- The return in a concern employing new and modern installations will be lower than that in a business which has old and worn out machines.

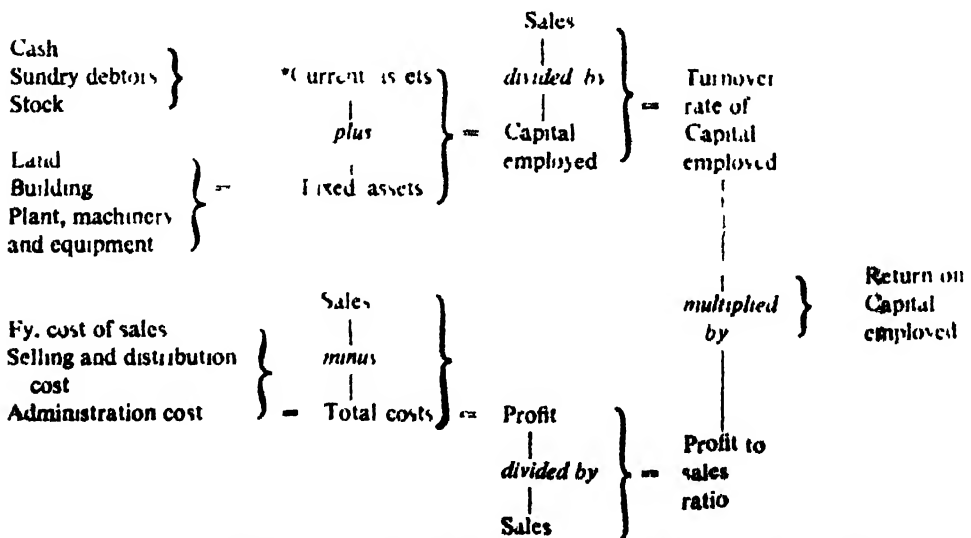
(iii) *Replacement cost* : Valuation of the assets on replacement cost basis for determining the return on capital has the following advantages :—

- Computation of the return is realistic as it conforms to current conditions ; profits are determined in real terms.
- Vitiation of inter-firm comparison due to assets in the various firms being purchased in different years does not occur.
- Earning capacity is related to present day conditions and present level of prices.

- (d) The return is not affected by the method or rate of depreciation.
- (e) It forms a suitable basis for price fixation.
- (f) The method is most useful in rising prices situations when both the actual cost and net value basis methods are rendered ineffective
- (g) It is immaterial whether modern and up to date or old machines are used
- (h) The best results are obtained when both the return and the assets conform to current conditions and current prices, e.g. when the return is computed under the discounted cash flow method and the assets on replacement cost basis.

The valuation may be either at full new replacement or at current replacement value, i.e. either at the cost on the anticipated date of replacement or at the estimated present cost of replacement under existing conditions. The main difficulty, however, lies in the assessment of the replacement cost particularly when value is subject to frequent changes. As in view of rapid technological advances the replacement of a machine at a future date can seldom be on a like to like basis, it is difficult to assess the future replacement value in terms of today's know-how.

Profit. For the determination of the ratio, profit to capital employed, the profit arising out of only the normal activities of the concern should be taken and windfalls and abnormal and unusual items of receipts and expenditure should be excluded. Profit unrelated to the period under consideration or to the capital not employed during that period should also be excluded. As investments outside the business are not taken into account, interest obtained from them should not be taken as profit for this purpose. Extending this principle to the case of interest on loan capital, there should be no objection to its being added back to profits because it forms a part of the earning on the total capital employed.



*Current liabilities are deducted if the concept of net capital employed is adopted.

Fig. 16.7. Elements making up the Return on Capital Employed.

The Profit and Loss Account shows the results of the working of a company for a definite financial period and the final figure of profit or loss exhibited therein

is the sum total of profit, loss, or break-even occurring from time to time, during the period, to which the account pertains. If there are wide fluctuations occurring during the period, a moving average figure may be adopted with advantage, to smooth out these fluctuations and make comparisons useful.

The various elements which go to make up the return on capital employed have been illustrated in Fig. 16.7. A change in any of these elements naturally influences the rate of the return.

Presentation of the Return. The return on the capital employed may be worked out and presented to the management on any of the undermentioned basis :

1. *On aggregate basis* : The return may be determined for entire capital employed in the concern.

2. *For each project* : This involves determination of the additional capital employed for each project separately and the additional return obtained from each.

3. *By departments* : For this purpose, the organisation is grouped into a number of departments employing similar types of capital and the return is worked out separately for each department.

4. *By products* : The return may be correlated to each product or group of products to find out the productivity of capital invested for each product separately. Though this is an ideal form of presentation, the difficulties involved in analysing the capital employed against each product are appreciable. For this purpose, each item of capital should be suitably analysed and apportioned to each product or product group. Such an analysis will reveal that while some items of capital employed (e.g., plant and machinery, buildings, sundry debtors and creditors etc. relating to only a single product) can be recognised as directly applied for a product, certain other items cannot be taken as earmarked for a specific product. In the latter case, suitable apportionment on the basis of past data will be required to be made. For instance, common fixed assets may be apportioned on the basis of quantity or costs of products, stock of materials on the basis of standard usage of such materials for each product and so on.

Allocation of profits to products or product groups is relatively simple as the revenue as well as the cost for each will be easily available. Costs for products passing through the same common processes may be apportioned on a technical basis. Alternatively, items of costs which are common to several products, and the related capital employed should be excluded for the purpose of calculation of the return.

5. *By each asset* : The yield obtained from the capital employed for each type of asset is worked out separately. The rates of return from plant and machinery, buildings, stock and sundry debtors will bring out the relative merits or otherwise of investment of funds in each of these assets.

In whatever manner the return be determined, the data do not on their own convey any meaning unless a comparison is made with a yardstick which might be taken to be the fair rate of return expected. It is difficult to determine the fair rate and opinion on this point varies. On a short-term basis, the bank rate may be adopted but a suitable rate of return would be the one expected for an investment which carries little risk.

Having decided upon a suitable expected return, evaluation of the performance of an investment may be made by computing the residual income.

The *residual income* method determines the residual income of a division after deducting from the actual operating income or profit of the division, interest (or return) computed on the investment in the division, at a stipulated satisfactory rate. The residual income is a measure of the efficiency of the division. Thus for a division for a year :

Actual profit	Rs. 80,000
Investment in the division	Rs. 300,000
Return on investment, 18% (expected)	Rs. 54,000
Residual income	Rs. 26,000

Utilization of the Return Data for Different Purposes. The rate of return may be utilized towards proper management control in the following manner :—

(i) *Inter-firm comparison* : The increasing interest in the technique of inter-firm comparison arises from the concept that although everything may be seemingly all right in an individual concern as seen from its working results, comparison with the results achieved by other concerns in the industry may often point out shortcomings not otherwise revealed. Thus, an idea of what others are earning in the same industry or in all the other industries will definitely lead to an improvement in the efficiency of the concern.

(ii) *Relative efficiency of each department* : The rate of return worked out in respect of capital employed in each department serves as a ready index for measuring its efficiency as also for comparison with departments engaged on similar or allied types of activities.

For the purpose of evaluation of departmental or divisional performance, the asset base used may be, (i) total assets including idle or excess assets, (ii) total assets employed, (iii) net working capital including other assets, or (iv) equity share. Method (i) is suitable if the department is made responsible for utilization of the idle or excess assets also but the total assets employed method is more appropriate if the departmental managers are not asked to control the idle or excess capacity. Since in method (iii), the current assets supplied by short-time creditors are included in the capital, the method is suitable if the managers are having a control over such short term credits and loans and are responsible for optimum utilization of the funds from these sources. The return on equity share does not provide a correct index for judging departmental performance as isolated from the borrowed capital, equity share has practically no relationship with operational activity, particularly when the concern is using financial leverage, i.e. trading on equity. (Trading on equity refers to the decision to borrow funds at a stipulated rate of interest with a view to earning a higher rate on such funds.) Let us consider the cases of two companies, A and B :

	Funds		Assets created	Gross return before interest	Interest 10%	Net return	% Return on	
	Equity shares	Borrowings and liabilities					Assets (GR/Asset)	Share holding (NR/Equity)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.		
A	2 lakh	—	2 lakh	50,000	—	50,000	25	25
B	1 lakh	1 lakh	2 lakh	50,000	10,000	40,000	25	40

The higher percentage of return on shareholding in the case of company B, which is trading on equity, is not because of any operational efficiency. This should not, therefore, be taken as a yardstick for measurement of performance.

The evaluation of the performance of departments or of product lines, discussed in the next paragraph, would be more meaningful if the concept of variability of capital employed is kept in view while calculating the return. Assets like sundry debtors and stock vary with the change in the operating level or sales, the rate of variability being different for different product lines and for different operating units. Fixed assets are more or less constant. In the third category, we may classify cash which is partly fixed and partly variable; some cash is required to maintain the plant even when activity is nil but the cash requirement increases with the increase in the activity level. The budgeted capital for two operating divisions in a company may be computed as follows :

Department Sales	A Rs. 2,00,000		B Rs. 3,00,000	
Capital employed :	Fixed Rs.	Variable %	Fixed Rs.	Variable %
Fixed assets	1,80,000	—	2,00,000	—
Sundry debtors	—	15	—	11
Inventory	—	30	—	25
Cash	2,500	5	2,500	4
	1,82,500	50	2,02,500	40
Total	Rs. 1,82,500 : .5 × Rs. 2,00,000		Rs. 2,02,500 + .4 × Rs. 3,00,000	
	Rs. 2,82,500		= Rs. 3,22,500	

The evaluation of performance of B is illustrated below :

	Budgeted		Period : Actual		Variance
	Rs.	Percentage	Rs.	Percentage	Rs.
Sales	3,00,000	100	2,90,000	100	10,000
Variable cost	1,80,000	60	1,88,500	65	8,500
Marginal Contribution	1,20,000	40	1,01,500	35	18,500
Fixed Cost	60,000	20	60,000	20.7	—
Profit	60,000	20	41,500	14.3	18,500
Fixed Capital	2,02,500	—	2,02,500	—	—
Variable Capital	1,20,000	40	1,30,500	45	10,500
Total Capital	3,22,500	—	3,33,000	—	10,500
Profit/Sales	20%	—	—	—	—
Sales/Capital	93%	—	—	—	—
Profit/Capital	18.60%	—	—	12.46%	6.14%

The variance of 6.14% may be analysed as follows :

(i) Due to lower activity level,

$$\begin{aligned}
 &= \frac{\text{Profit lost}}{\text{Budgeted capital}} \\
 &= \frac{\text{Loss of sales—budgeted cost of lost sales}}{\text{Budgeted capital}} \\
 &= \frac{\text{Rs. } 10,000 - 0.6 \times \text{Rs. } 10,000}{\text{Rs. } 3,22,500} = 1.24\%
 \end{aligned}$$

(ii) Due to higher costs,

$$= \frac{\text{Actual cost} - \text{budgeted cost of actual sales}}{\text{Budgeted capital}} = \frac{\text{Rs. } 1,88,500 - 0.6 \times \text{Rs. } 2,90,000}{\text{Rs. } 3,22,500} = -4.49\%$$

(iii) Due to excess capital employed,

$$= \frac{\text{Actual return}}{\text{Budgeted capital}} - \frac{\text{Actual return}}{\text{Actual capital}} = \frac{\text{Rs. } 41,500}{\text{Rs. } 3,22,500} - \frac{\text{Rs. } 41,500}{\text{Rs. } 3,33,000} = 0.41\% - 6.14\%$$

(iii) *Profitability of each product* : The analytical data obtained by applying the technique of marginal costing to the determination of profitability of individual products in a mix may be supplemented by presenting the rate of return obtained on the capital employed for each product. The return reveals cases where a particular product is blocking up heavy resources of the concern with no return or with very small return.

The evaluation of profitability of the products and of the performance of various product lines and the analysis of variances may be done in a manner similar to those used in the case of operating departments or divisions, as described above.

(iv) *The effect of employment of each type of asset* : The effect of heavy investments in stocks of components, sub-assemblies, raw materials, and work-in-progress is to slow down the turnover of capital employed. If an analysis is made of the return from the capital employed on each type of asset, the effect of idle and unremunerative capital may be specially brought to the notice of the management. A simple presentation of the comparative effect of large overstocking is given below. Similar analysis may be made in respect of the other types of capital employed.

Effect of overstocking on the return on capital employed

	Normal stock	Current stock
Value of stock :	Rs.	Rs.
Raw materials	40,000	60,000
Work-in-progress	5,000	10,000
Finished good	5,000	9,000
Sales	20,000	20,000
Cost of sales	18,000	18,000
Profit	2,000	2,000
Profit/Sale	10%	10%
Return on capital employed		
Raw material	5%	3.3%
Work-in-progress	40%	20%
Finished goods	40%	22.2%

(v) *Repayment of loans* : Repayment of the interest and instalments of loan capital takes priority in the matter of allocation of the profits of a business. When embarking upon a programme for which borrowed funds are proposed to be utilized, the return as assessed under the payback method gives an indication as to what extent and within what period it will be possible to return the loan and the interest there on.

(vi) *Analytical tool for control of capital expenditure* : Determination of the rate of return on the capital employed and its proper analysis is necessary for the purpose of :

- (a) assessment of the profitability of the scheme/project to ensure best utilization of funds, and
- (b) measurement of the results while the project is in progress and also on completion of the programme.

(vii) *Making policy decisions* : Management is often confronted with the problem of making policy decisions on certain proposed changes to be effected in a department, a product, or method of manufacture, or on alternative proposals where the line of difference may not be sharp, such as whether to make or buy a component, raw materials, tools, or equipment, whether to purchase a building or have it on rental basis, etc. One of the important factors to be taken into account in arriving at a final solution will, no doubt, be the resultant change in the level of profit, but the rate of return on the capital invested on alternative proposals should be the overall guiding factor.

Improving the Return. Being the product of two ratios, viz. profit to sales and capital turnover, the return on capital may be improved by increasing either or both of the two subsidiary ratios. This may be achieved through managerial action, a few of which are stated below :

Improving the Profit/sales ratio. If, for example, the profit/sales and sales/capital employed ratios be 40/100 and 100/120 respectively, the return on capital will be $(40/100) \times (100/120) = 33\frac{1}{3}\%$. If profit be increased to 50, say by lowering costs, the return will be, $(50/100) \times (100/120) = 41\frac{2}{3}\%$.

The profit/sales ratio may be improved by :

- (i) Increasing the sales volume (by increasing capacity utilization and/or through sales promotion) or selling price to yield larger profit margin.
- (ii) Reducing costs.
- (iii) Effecting improvement in the planning of production and sales.
- (iv) Improving the product-mix to give a higher P/V ratio.
- (v) Introducing a management incentive plan for improving the return.

Improving the capital turnover : Capital turnover may be improved by :

- (vi) As at (i) above
- (vii) Reducing the volume of assets to the lowest possible level. This can be achieved by methods of control over capital expenditure, decreasing fixed assets to the minimum consistent with operational efficiency, reduction in inventory investment, increasing the productivity of the assets, minimising cash in hand, prompt billing and collection of credit, and obtaining longer periods of credit from suppliers. If, for example, the assets employed be reduced from 120 to 100, the return will be, $(40/100) \times (100/100) = 40\%$.
- (viii) Through optimum use of available assets, i.e. maximising capacity utilization, and reduction of surplus capacity. .

Limitations of the Return on Capital technique. The limitations of the technique of the rate of return arise mainly due to the difficulties involved in determination of the return and its correct interpretation. These limitations are :

- (i) While applying the rate of return to measure internal performances, it

is difficult to apportion profit, costs, and capital employed among the various divisions of the concern.

- (ii) As is the case with all techniques and tools of management control, the ratio between profit and capital cannot be a substitute for managerial judgement. The tendency sometimes is to lay stress more on the ratio rather than on the amount of profit.
- (iii) Attaching too much importance to financial ratios and trends distracts the attention of the management from the technical aspects of research, production, personnel management, sales, etc.
- (iv) As wide differences exist in the age of the various assets, the conditions in which they work and the state of maintenance and repairs in which they are kept, rates and methods of charging depreciation, and methods of valuation of stock, it is not practicable to have a uniform rate of return which would be suitable for all the sectors of the concern.
- (v) Return on capital is not a suitable technique for appraising short term performances.
- (vi) Rigid adherence to the return without keeping in view the peculiar situations and circumstances of a case, may lead to erroneous conclusions and embarking upon wrong policies.
- (vii) The executives concerned may consider the rate of return to be unfair for evaluation of performance if such a rate is fixed without their agreement.

WORKING CAPITAL

In a manufacturing business, working capital provides funds with which raw materials are purchased, wages are paid to the workers who process the raw

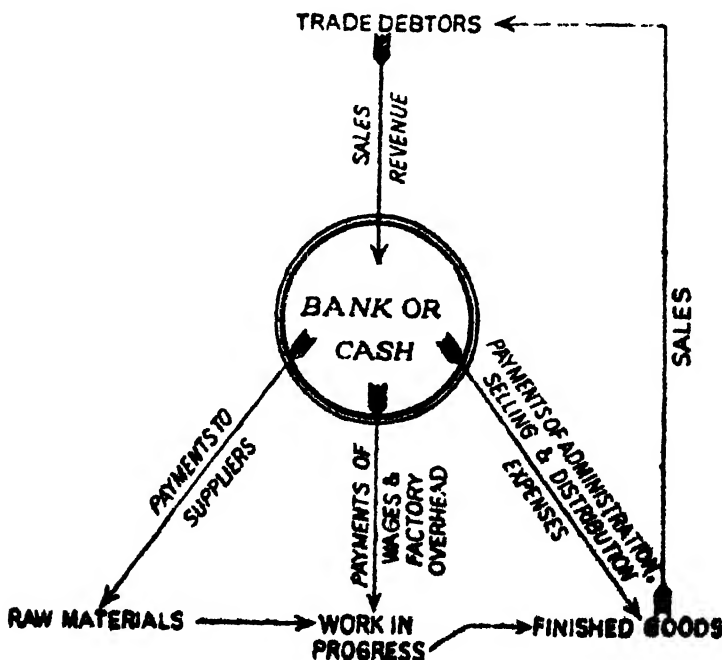


Fig. 16.8. Working Capital Cycle

materials, and other expenses in the form of manufacturing, administration, selling, and distribution overhead are met. The raw materials are transformed into work-in-progress and finished products, and the finished products when sold provide funds which again, are available for meeting expenditure on raw materials, etc., thus completing the working capital cycle, i.e. the period starting from the date of payment to creditors and ending on the date of realisation of credit from sales. As the products are sold at a profit, there is continuous growth of the capital employed unless the entire profit, after taxation, is appropriated towards payment of dividends.

The working capital cycle is illustrated in the diagram in Fig. 16.8. The length of the working capital cycle depends upon the following :—

- (i) Period of credit given by suppliers.
- (ii) Length of the production cycle.
- (iii) Period of storage of raw materials.
- (iv) Period of storage of finished goods.
- (v) Period of credit allowed to customers.

Shorter the working capital cycle, the smaller will be the funds required to meet the needs of working capital. The requirements of working capital may, therefore, be reduced by shortening the periods at (ii) to (v) above, and lengthening the period at (i). Any reduction in cost of production or an increase in the revenue has the effect of ploughing back more profits in the business and thus contributing to increased working capital growth.

The requirements of working capital may be determined by analysing the working capital cycle in the manner illustrated below :

<i>Material</i>	Months
Raw material storage period (in stock)	2
Production cycle (work-in-progress)	3
Finished goods storage period	1
Period of credit to customers (debtors)	$\frac{1}{2}$
Less Period of credit from suppliers (creditors)	$(-)\frac{1}{2}$
	—
Working capital (Material) cycle	6
	—
<i>Labour</i>	
Production cycle (work-in-progress)	3
Finished goods storage period	1
Period of credit to customers (debtors)	$\frac{1}{2}$
Less Time lag for wage payment (credit from employees)	$(-)\frac{1}{2}$
	—
Working capital (Labour) cycle	$4\frac{1}{2}$
	—
<i>Overhead</i>	
Production cycle (work-in-progress)	3
Finished goods storage period	1
Period of credit to customers (debtors)	$\frac{1}{2}$
Less Time lag for payment	$(-)\frac{1}{2}$
	—
Working capital (Overhead) cycle	4
	—

If the material, labour, and overhead costs per month be Rs. 20,000, Rs. 22,000, and Rs. 15,000 respectively, the working capital requirement will be :

Material	Rs. 20,000	6	Rs. 1,20,000
Labour	Rs. 22,000	4½	Rs. 93,500
Overhead	Rs. 15,000	4	Rs. 60,000
			Rs. 2,73,500

This may be presented in another form as follows -

Months	Total	Raw materials	Work-in-progress	Finished goods	Debtors	Creditors
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
<i>Materials</i>						
In stock	2	40,000				
In work-in-progress	3		60,000			
In finished goods	1			20,000		
Credit to debtors	½				10,000	
Less credit from creditors	½					10,000
Total	6	1,20,000				
<i>Labour</i>						
In work-in-progress	3		66,000			
In finished goods	1			22,000		
Credit to debtors	½				11,000	
Less time lag for payment	½					5,500
Total	4½	93,500				
<i>Overhead</i>						
In work-in-progress	3		45,000			
In finished goods	1			15,000		
Credit to debtors	½				7,500	
Less time lag for payment	½					7,500
Total	4	60,000				
		Rs. 2,73,500	Rs. 40,000	Rs. 1,71,000	Rs. 57,000	Rs. 28,500 (-)
						Rs. 23,000

In order to compute the total requirement of working capital, the following amounts should be added to or deducted from the above figures :—

Add	Deduct
Estimated cash balance	Other outstanding payments
Safety margin, if any (on the total or in respect of specific items)	
Other prepaid expenses	
Profit on sales to debtors	

Another illustration showing the method of calculation of working capital is given below.

EXAMPLE 16.10.

From the following information, you are required to estimate the net working capital :

	<i>Cost per unit</i>
	Rs.
Raw Material	400
Direct labour	150
Overheads (excluding depreciation)	300
	-
Total Cost	850
	-
<i>Additional information :</i>	
Selling price	Rs. 1,000 per unit
Output	52,000 units per annum
Raw material in stock	average 4 weeks
Work-in-progress (assume 50% completion stage with full material consumption)	average 2 weeks
Finished goods in stock	average 4 weeks
Credit allowed by suppliers	average 4 weeks
Credit allowed to debtors	average 8 weeks
Cash at bank is expected to be	Rs. 50,000

Assume that production is sustained at an even pace during the 52 weeks of the year. All sales are on credit basis. State any other assumptions that you might have made while computing.
(I.C.W. 4., Final)

ANSWER :

Current Assets :

		Rs.
Raw material stock	$\frac{52,000 \times 400 \div 4}{52}$	16,00,000
Work-in-progress		
(a) Raw material	$\frac{52,000 \times 400 \div 2}{52}$	8,00,000
(b) Direct labour and overhead	$\frac{52,000 \times 225 \times 2}{52} =$	4,50,000
(50% completion stage)		
Finished goods stock	$\frac{52,000 \times 850 \div 4}{52} =$	34,00,000
Debtors	$\frac{52,000 \times 1,000 \div 8}{52} =$	80,00,000
Cash at Bank		50,000
Total		Rs. 1,43,00,000

Current Liabilities :

Creditors	$\frac{52,000 \times 400 \div 4}{52}$	16,00,000
-----------	---------------------------------------	-----------

Net working capital Rs. 1,27,00,000

The only assumption made is that materials are introduced at commencement of the process.

Shortage of working capital has a far reaching effect on the economic position of a business and in the extreme case, it may cause winding up of the concern. In addition, working capital shortage has the *disadvantages* stated overleaf.

- (i) Bottleneck in production due to shortage of material and other facilities—sufficient stock of materials cannot be maintained.
- (ii) Benefit of bulk purchase of materials is not availed of, resulting in higher cost.
- (iii) Breakdown of plant which is worn out and is not properly maintained due to shortage of funds.
- (iv) High rates of interest may have to be paid on loans obtained.
- (v) Low inventory of finished goods creates difficulties in selling.
- (vi) It is a bad business to have creditors pressing for payment all the time. Discounts which would normally be obtained are lost.
- (vii) Loss of business may occur due to the concern's inability to offer suitable credit terms to customers. Heavy discounts may have to be offered to get cash quickly.
- (viii) The firm loses prestige in the stock exchange. There is a drop in the value of shares and the prospective investors are scared. Acute shortage of cash may result in insolvency and liquidation.

It will be obvious from the above that a strict control of the working capital is essential for the smooth running of a business. The following steps may be taken to ensure that sufficient working capital is available at all times : --

- (i) Minimum capital investment in inventory of materials, work-in-progress and finished goods. Planning a suitable purchase programme, fixation of stock levels, reduction in cost of handling, and scrutiny of slowmoving stocks ensure that the stock of materials is kept at the minimum. Reduction in the stock of work-in-progress and finished products may be effected by controlling the rate of production and the rate of despatch of goods.
- (ii). Avoiding extension of delivery period.
- (iii) Prompt disposal of goods which are of a perishable nature or which are likely to be out of fashion.
- (iv) Strict credit control such as prompt invoicing, follow up of overdue accounts, better discount terms, investigation of creditworthiness of customers, scrutiny of bad debts and doubtful debts, etc.
- (v) Control of cash resources through budgets.
- (vi) Payment according to the priorities in order to obtain the maximum advantage of discounts offered.
- (vii) Reduction of the production cycle through technical investigation.

EXAMINATION QUESTIONS

1. A comprehensive and forward looking system of capital expenditure control is an element of successful company development. Discuss why capital expenditure merits special consideration and analyse the objectives of and the approach to efficient capital expenditure control. (I.C.W.A., Final)
2. A general criticism about capital expenditure plans is that actuals far exceed the estimates and that longer time is taken for the execution of the various works.
State the probable reasons for this state of affairs and suggest the steps you will take to control the same. (I.C.W.A., Final)
3. There is a proposal to introduce additional capital into a business for the purpose of (a) replacing old machinery by up to date ones, and (b) enlarging the capacity of the production department by acquisition of additional equipment and buildings.

What factors should be taken into consideration before launching on the proposals? Draw up a report to your Chief Executive on those lines.

(I.C.W.A., Final)

4. The only values that are irrelevant for all decisions on what to do with a specific asset are the original cost and its book value. In any replacement decision, the book value of the existing equipment is completely irrelevant.

Examine this challenge to the orthodox technique and suggest alternative techniques, if any, to guide, replacement decision.

(I.C.W.A., Final)

5. What are the principal methods employed for ascertaining the profitability of capital expenditure projects? Write short notes on any two methods.

(I.C.W.A., Final)

6. Describe with an illustration how you would choose between a few alternative capital projects.

(I.C.W.A., Final)

7. Explain briefly the following methods of ascertaining the profitability of capital expenditure projects, bringing out the advantages and limitations of each:

(a) Pay-back method.

(b) Return on investment methods.

(I.C.W.A., Final)

8. In order to assist the management in deciding upon the desirability of replacement of existing assets, the cost accountant should make a comparative study of the profitability of alternative schemes.

Discuss the factors on which you will focus attention when the problem involves the replacement of existing machine with a new one which would perform a similar task.

(I.C.W.A., Final)

9. It is the practice of a large manufacturing organisation to put all its capital expenditure work, with the exception of general purpose machine tool purchase, through its civil and plant engineering section. These sections also undertake the maintenance and repairs of the company's assets.

Describe the system you would use to ensure accurate cost ascertainment and adequate cost control of capital expenditure in these circumstances.

(I.C.W.A., Final)

10. How will you control capital expenditure in a developing company? Design a simple form for capital expenditure control reporting.

(I.C.W.A., Final)

11. Your firm has decided to construct an extension to the factory buildings. What will be the accounting procedure from the date of decision to the date of completion and how do you propose to control the expenditure.

(I.C.W.A., Final)

12. 'Return on capital' is the product of 'Profit margin' and 'Capital turnover'. Amplify the statement and state how this technique is used for managerial purpose.

(I.C.W.A., Final)

13. Discuss the concept of 'Return on Investment' and its practical application in industrial concerns. What management action is required to improve the return?

(I.C.W.A., Final)

14. In the present increasing price index, on what basis would you value fixed assets for computing capital employed and for top decisions?

Give reasons for and against your argument.

(I.C.W.A., Final)

15. Your Company is a multi-product complex and one of its products, which hardly constitutes 2% of the total turnover has been brought under cost audit.

Your cost auditor requires of you an assessment of the capital employed for the product under review. Briefly list out the steps, you will take to assess its capital employed.

(I.C.W.A., Final)

16. A process plant was erected at a cost of Rs. 100 lakhs and depreciated in the books at 62 per cent per annum of the original value. After 10 years, a portion of the plant, the original cost of which was Rs. 20 lakhs, was worn out, which necessitated a replacement at a cost of Rs. 30 lakhs to carry the plant through the rest of its life. The actual production of the plant till replacement was only about 80 per cent of the capacity. As a result of the replacement, the expected production would increase to 90% of the capacity.

How will the addition to the plant be treated in financial and cost accounts?

(I.C.W.A., Final)

17. (a) What do you understand by the term "Sunk Cost"?

(b) A factory is considering the replacement of an old semi-automatic lathe by a new high speed capstan lathe. The following information is available regarding the old and proposed new machines :

	Old lathe	Proposed new lathe
Cost of machine	Rs. 63,000	Rs. 22,000
Salvage value	Rs. 3,000	Rs. 1,000
Estimated life	15 yrs.	15 yrs.
Production per hour	10 pcs.	15 pcs.
Estimated load per annum	4,000 hrs	2,000 hrs.
Operator's wages per hour	Rs. 2.50	Rs. 3.50
Operating expenses per annum excluding depreciation	Rs. 8,000	Rs. 10,000
Present market value of old machine	Rs. 2,000	

Write a short report to management on the financial implications of the proposal comparing cost of production on the old and new machines. At what level of output will the costs break-even? (I.C.W.A., Final)

18. A product can be manufactured on engine, turret or automatic lathe. The total fixed cost includes estimated operating costs per unit of production

Lathe	Total Fixed cost	Variable cost per unit
	Rs.	Rs.
Engine	50	1.00
Turret	200	0.50
Automatic	500	0.30

Find out the number of units, maximum or minimum as the case may be, that would be economical to produce in each of these lathes.

If the turret lathe is not available and the choice is between engine and automatic lathes, what will be the new economic production? (I.C.W.A., Final)

19. A manufacturer who required soft water for certain process designed and installed a water-softening plant at a cost of Rs. 56,000. As the town was going to install a municipal water softening plant in 7 years he decided to write off the cost of this plant in 7 years. A year later, on finding his operating costs come up to Rs. 8,000 a year he consulted a specialist firm dealing with similar equipment, who offered to put up a plant for Rs. 36,000. They also guaranteed an operating cost of Rs. 3,000 per year. The existing plant can be disposed of for Rs. 18,000. You are required to advise the manufacturer what he should do. (Ignore taxes and scrap value after 7 years). (I.C.W.A., Final)

20. An oil company proposes to instal a pipeline for transport of crude from wells to refinery. Investments and operating costs of the pipeline vary for different sizes of pipes (diameter)

The following details have been collected :

Pipeline diameter	3"	4"	5"	6"	7"
Investment required (Rs. lakhs)	16	24	36	64	150
Gross annual savings in operating costs before depreciation (Rs. lakhs)	5	8	15	30	50

Estimated life of the installation is 10 years. Tax rate is 50%. Ignore investment allowance. Calculate the net savings after tax and the cash flow generation; from these recommend the largest pipeline to be installed if the company desires a 15% after tax return. Also indicate the proposal that has the shortest payback.

(I.C.W.A., Final)

21. Your company can make either of the following two investments at the beginning of 1984. The particulars available in this respect are :

		Project I	Project II
Estimated cost (to be incurred initially)	(Rs)	20,000	28,000
Estimated life	(Years)	4	5
Scrap value at the end of estimated life		Nil	Nil
Estimated Net Cash Flow (Rs.):			
End of 1984		5,500	5,600
End of 1985		7,000	9,000
End of 1986		8,500	9,000
End of 1987		7,500	9,000
End of 1988			9,000

It is estimated that each of the alternative projects will require an additional working capital of Rs. 2,000 which will be received back in full after the expiry of each project life. In estimating net cash flow depreciation has been provided under straight line method.

Cost of finance to your company may be taken at 10% per annum. The present value of Re. 1, to be received at the end of each year, at 10% is given below :

Year	1	2	3	4	5
P.V.	0.91	0.83	0.75	0.68	0.62

Evaluate the investment proposals using Net Present Value and Profitability Index Methods. (I.C.W.A., Final)

CHAPTER 17

PRICING METHODS

PRODUCT PRICING

Costs for Product Pricing. The price of a product is influenced by a large number of factors, such as,

- (i) *Costs* (actual, imputed and replacement costs)
- (ii) *Non-cost factors* :
 - (a) Nature of the industry
 - (b) Characteristics of the products
 - (c) Degree of competition within and outside the industry
 - (d) Purchasing power of the customers
 - (e) Elasticity of supply and demand
 - (f) General economic conditions
 - (g) Price agreements
 - (h) Availability of substitutes
 - (i) Restrictions imposed by the Government on production, price, and imports
 - (j) Level of plant activity
 - (k) Inventory accumulation
 - (l) Management policy

Although one or the other of these factors may at times predominate, cost is the most important factor influencing price. In the long-term, price tends to equate with cost plus profit and no business can survive unless it is able to recover all its costs and in addition, earn a reasonable return on the capital invested. Cost may be a primary factor where price is negotiated on the basis of cost plus contract or where price is regulated by the Government. In the short-term, determination of price follows the economic law of demand and supply. A decrease in supply or increase in demand pushes up the prices whereas an increase in supply or decrease in demand brings the prices down. In a state of perfect competition, i.e. when the action of any one concern does not have the effect of altering the market price, the management have obviously very little to do about price fixation and cost plays practically no role in setting prices for individual firms. The profit position in such a case may be improved through various other methods such as costs reduction, change in product mix so as to place more profitable products in the market, and change over to new or improved products to attract better prices. On the other extreme, when a manufacturer has the monopoly or near monopoly of a product, he can exert complete influence and control over price without any considerations of costs. The tendency is to fix a price which would fetch the highest return keeping in view the elasticity of demand. Almost similar situation arises in the state of oligopoly when the total supply of a commodity is controlled by a few and

the larger units in the industry or business act as the "price makers". In between the two extremes of perfect competition and monopoly, there is a state of imperfect competition—a situation which commonly exists in most industries. It is in this market that the skill and knowledge of the price fixer is called for most.

In the case of a new product, a *trial price* may be fixed as a sort of 'feeler' to determine whether the market can bear it; if not, the price is suitably revised. In order to get a hold over the market for a new brand, sometimes a low price known as the *penetration price* is set in the beginning at a deliberately low level. On the other hand, a very high price may be fixed in the initial stages for such new products the novelty of which is likely to wear off within a short period. This *skimming price* as it may be called, may be necessary in the initial stages when production has not been fully established and supplies to the market are limited. The price may be gradually reduced when production steps up and supply to the market is built up.

Costs, no doubt, influence price but they do not control or regulate them. This is because firstly, price is not determined by cost alone, specially in the short term and secondly, being the aggregate of a number of diverse elements which may be arranged in a variety of ways, product cost varies according to the cost accounting procedure adopted. Costs may, therefore, be taken only as guides and reference points for the purpose of price fixation; they represent a resistance point to the lowering of price because no enterprise can afford to sell at a price below costs on a long term basis. We have seen that while cost is the most important factor in cost plus pricing, it is of little significance in times of severe competition or during trade recession. In the case of joint product industries, the position is reversed; it is the price which influences costs. Thus, costs play a role which varies from one extreme to the other depending upon the particular situation under which a price decision is required to be made.

Pricing is primarily the top management's exercise in profit planning. Due to the close relationship between costs and prices, the cost accountant is required to play a very important part in price decision making. He can assist the management by providing information on the following aspects:

- (i) Detailed cost analysis to suit particular pricing situations pointing out the limitations of conventional costing when applied to pricing problems.
- (ii) Future costs which may be either total, marginal, and estimates for tendering and price quotations.
- (iii) Effect of demand, competition, and price changes on profitability.
- (iv) Comparison of actual profits with projected profits, arising out of a particular price decision.
- (v) Profits on various product mix—overall profit and profits by products.
- (vi) Return on capital employed under varying conditions, prices, product mix, and levels of output.
- (vii) Effect of price differential, e.g. different prices for different classes of customers, export and home markets and different rates of discounts and concessions granted.

The necessity for pricing decision may arise when (i) a new product is to be placed in the market, (ii) market cannot be penetrated at existing price or there is customers' resistance to the existing price, (iii) quotations or bids are to be made for the products or offers are received for purchase at a specific price, and (iv) some products are yielding profits lower than expected.

Pricing Methods based on Costs. The following methods of pricing based on costs may be used : --

1. *Full cost (or Total cost) method of pricing* : Under this method, selling price is determined as total costs plus a mark up to cover profit. To arrive at the selling price, selling, distribution, and administration overhead and an estimated or desired percentage of profit are added to the total factory cost, i.e. to the total of direct labour, direct material, direct expenses, and variable and fixed manufacturing overhead. The total costs for this purpose may also include opportunity costs, if any. Either standard (or estimated), or historical costs may be taken but as pricing is applicable to future only, the historical costs should be adjusted to anticipated conditions during the period for which the price is fixed..

Total cost pricing method is suitable for cost plus contracts and for new products having no established market. The method is commonly used where competitive conditions are non-existent or are not significant.

The desired profit to be added to the costs, i.e. the *mark-up* may be computed as follows : --

- (i) As a percentage of total cost of sales, i.e. factory costs plus administration, selling, and distribution costs.
- (ii) As a percentage of sale price.

In method (ii), a percentage, x , of profit expected on sales will work out to

$$\frac{100x}{100-x} \% \text{ on total cost.}$$

The total cost method has the following *advantages* and *limitations* : --

Advantages :

- (a) It is suitable for long-term pricing as full costs are recovered and profit is maximised in the long-term.
- (b) It tends to stabilise the price in the market.
- (c) It is the safest method of pricing.

Limitations :

- (a) Being entirely cost oriented, the price ignores the elasticity of demand and other external factors affecting the market.
- (b) It ignores the factor of competition and assumes a static condition of performance efficiency. Other competitors may work more efficiently and reduce costs and thus offer lower prices.
- (c) Inclusion of fixed cost for pricing may sometimes result in a wrong decision due to non-acceptance of certain orders which do not cover the total costs. Selling below total costs so as to recover the marginal costs

(inclusive of traceable fixed costs, if any) or out of pocket costs, may at times earn more profit, e.g. in the case of additional sales under a new brand name or in foreign market when the fixed costs have already been recovered in full in existing sales.

- (d) Selling price fixed as a percentage of cost gives the impression that all products do not earn the same amount of profit. The percentage added may not sometimes be adequate from the point of view of expected return on capital employed.
- (e) Price based on previous or current costs does not reflect the correct position as only future market prices of inputs are relevant to pricing decisions.
- (f) Costs like fixed cost, administration cost, cost of capital goods etc. decrease per unit as volume increases. Even direct costs may decrease with increase in volume. For example, purchase costs of material may decrease in case of large purchases and labour cost may decrease due to the operation of the learning factor where the efficiency of the worker increases as production increases. The selling price fixed on the basis of such fluctuating costs will not be correct unless an optimum operating size is determined and the total costs relevant to that level of operation is adopted as the basis for pricing.
- (g) The costs adopted for pricing are not always very precise because of the arbitrary nature of apportionment of common costs.

2. *Conversion cost method* : The conversion cost (total costs minus cost of material input cost) method of pricing is based on the contention that because materials do not earn any profit, profits should be related to the services performed, i.e. the value added in the form of conversion cost. Other things being equal, it would be advantageous to manufacture a product with comparatively lower conversion cost as less efforts would be necessary to earn the same or higher profits. Under the total cost method, the profits on two products with widely differing material contents but equal conversion cost will be unequal. Further, a product with high material cost but low conversion cost may show almost the same profit as another product with low material cost but high conversion cost. The conversion cost method removes these anomalies but how far it is correct to say that materials do not contribute to the profit is a debatable point.

3. *Return on investment method* : This method takes into account the capital employed for financing the production and sales of the product line. The formula for fixing a selling price which will yield a desired return on capital employed is :

$$P = \frac{(C + xF)/U}{1 - xV}$$

Where P = Selling price
 C = Total cost, i.e. factory cost and administration, selling and distribution costs
 x = Rate of return desired on capital employed
 F = Fixed capital employed (fixed assets)
 V = Variable portion of capital employed (as percentage of sales units)
 U = Annual sales (units)

The method is useful for :

- Fixation of price of new products for which there is no established market price.
- Price fixing for products which utilise varying capital investments.
- Comparison of the existing profit with the desired profit (where the product has an established market price) with a view to deciding whether to continue manufacture of the product.
- Make or buy decisions.

An example illustrating the return on investment method is given below :

EXAMPLE 17.1.

Metal Products Ltd. have received an enquiry for the supply of 2,00,000 numbers of a special type of machine screw. Capacity exists for manufacture of the screws in the company's unit no. 3, but a fixed investment of Rs. 60,000 and working capital to the extent of 25 per cent of sale value will be required if the job is undertaken. The costs are estimated as follows :—

Raw material—20,000 lbs. @ Rs. 2.30 per lb.

Labour hours, direct—18,000, of which 2,000 would be overtime hours payable at double the labour rate.

Labour rate—Re. 1 per hour.

Factory overhead—Re. 1 per direct labour hour.

Selling and distribution cost—Rs. 23,000.

Material recovered as scrap at the end of the operations is estimated at Rs. 2,000.

The company expects a net return of 25 per cent on the capital employed.

Prepare a cost and price statement indicating the price which should be quoted to the customer. (I.C.W 4, Final)

ANSWER :

Product : Machine Screws

Specification M.S L. 1½"

Quantity required : 2,00,000

Raw material 20,000 lb. @ Rs. 2.30 per lb.	Rs. 46,000	
Less Scrap recovered	Rs. 2,000	
		Rs. 44,000
Labour 16,000 normal hours, Re. 1 per hour	Rs. 16,000	
2,000 overtime hours, Rs. 2 per hour	Rs. 4,000	
		Rs. 20,000
Fy. Overhead @ Re. 1 per direct labour hour		Rs. 18,000
Factory cost		Rs. 82,000
Selling and Distribution cost		Rs. 23,000
Total cost		Rs. 1,05,000
Anticipated profit, 25% of (Rs. 60,000 + Rs. 32,000)		Rs. 23,000
		Rs. 1,28,000
Suggested selling price		Re. 0.64

Suggested selling price per unit

Working capital and selling price are worked out as follows :—

Return on working capital = $\frac{1}{4}$ th of the amount of working capital
or $\frac{1}{16}$ th of the amount of sales

Total cost + return on fixed assets = Rs. 1,05,000 + Rs. 15,000 = Rs. 1,20,000

This is equal to 15/16th of sales

Sales = Rs. 1,28,000 and Working capital = Rs. 32,000.

If in the example given above, the working capital be assumed to be the variable portion of the capital employed, sale price per unit may be arrived at with the help of the formula (Page 849) as follows :—

$$P = \frac{(1,05,000 + 0.25 \times 60,000) / 2,00,000}{1 - 0.25 \times \frac{32,000}{2,00,000}} \quad \text{Rs. 0.625 per unit}$$

Note : Assuming a profit of 20% on total cost, or 16⅔% on sale price, or 35% on conversion cost, the price under the methods discussed previously will be as follows :—

Total cost (percentage on cost)

Total cost	Rs. 1,05,000
Profit (20% on cost)	Rs. 21,000

Price	Rs. 1,26,000
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Total cost (percentage on sales)

Total cost	Rs. 1,05,000
Profit (20% on cost 16⅔% on sales)	Rs. 21,000

Price	Rs. 1,26,000
-------	--------------

Conversion cost

Raw material	Rs. 44,000
Conversion cost	Rs. 61,000

Total cost	Rs. 1,05,000
Profit (35% on conversion cost)	Rs. 21,350

Price	Rs. 1,26,350
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4. *Marginal cost method :* The use of the marginal costing technique in pricing decisions was discussed in Chapter 9. The marginal method has a flexible approach and it is particularly useful in short term pricing situations. Raising of prices lowers demand and the corresponding revenue. On the other hand, lowering of prices may increase demand and revenue but the cost may increase if, for instance, overtime is worked to meet increased demand, so that this may result in an over-all reduction of profit. Marginal analysis brings out the effect of potential price differential so that an optimum price and an optimum volume of operation that will ensure the greatest profit improvement may be suggested.

5. *Differential cost method :* Differential cost analysis reveals that a lower price is acceptable so long as the extra revenue is able to meet the additional cost and also earn some profit, provided this does not disturb the market. In the long run, however, reduction in price has an adverse effect on the market ; severe competition may set in and the concern may find itself faced with an undesirable price cutting situation.

6. *Standard cost method :* Standard costs assist in determination of fairly accurate estimates of selling prices. Standard costs may be used in fixing catalogue prices of standard products and also for price quotations. In either case, the problem is simplified as standard costs are promptly and readily available. The standard costs should be suitably modified to reflect current conditions. Before making price decisions, it would also be necessary to revise or adjust the standard costs for long term persistent variances, if any, so as to make the former conform to the real situation.

7. *Learning curve method :* For a detailed discussion of the technique of learning curve (or improvement curve), reference may be made to Chapter 18. The

technique is developed for the pricing of products in undertakings that underake large and costly non-repeat orders of varying sizes. Each batch of an item is produced according to customer's specification and the cost per unit varies with the quantity on order. As the quantity increases, the unit cost tends to decline. This is because the workers gain experience and efficiency and so take less time for the repeat operations and also because the set up costs are spread over a larger quantity of production. The learning curve technique takes the efficiency factor into account, and briefly, the assumption is that as the quantity produced is doubled, the cumulative production hours per unit are reduced at a constant rate, the rate of reduction varying from industry to industry. For example, an 80% learning curve, in an industry would indicate that as the production doubles, the cumulative average hours per unit for a batch of production will be 80% of the hours for the previous batch. Assuming that the material costs per unit remain constant for different batches of production and that the labour operations do not change, the decline in the price per unit for a product in batches of increasing size, will be as follows :—

Units of production	Material cost per unit	Labour and overhead costs per unit	Fy. cost per unit	Selling and distribution expenses and profit per unit (30% of Fy cost)	Price per unit
	Rs.	Rs	Rs	Rs	Rs
10	2,000	1,000	3,000	900	3,900
20	2,000	800	2,800	840	3,640
40	2,000	640	2,640	792	3,432
80	2,000	512	2,512	754	3,266

It may, however, be noted that after reaching an optimum limit of production, the learning phase levels off. At this stage, there is nothing further to be learnt and so no more future savings can be expected.

The various methods of pricing discussed above should not be taken as exclusive. In fact, while dealing with pricing problems, the management would make the best use of most of the techniques and take into consideration the essential features of the various methods that would be suitable under varying circumstances and conditions.

An example to illustrate fixation of price is given below :

EXAMPLE 17.2.

A company is asked to quote for a special order to be delivered ex-works

Direct material costs per unit of output are :

For a total of : 100 : Rs 18 each

200 : Rs 18 less 10% discount each

400 : Rs 18 less 20% discount each

The work would be done in two departments :

Department F employs highly skilled operator paid at Rs. 2.50 per hour. Each unit of output requires 6 direct labour hours of work for the first 100 units. However, experience has shown that an 80% learning curve can be expected to operate.

Department G employs skilled operators paid at Rs. 2.00 per hour. Each unit of output requires 3 direct labour hours of work for the first 100 units. Here, too, an 80% learning curve is expected.

Overtime in either department is paid at time and a half. No premium for overhead is included in standard manufacturing overhead.

Standard manufacturing overhead per direct labour hour is as follows :

	Department F	Department G
	Rs.	Rs.
Variable	1.00	1.00
Fixed	3.50(a)	2.00(b)

(a) based on a budgeted level of 3,000 direct labour hours per period ;

(b) based on a budgeted level of 2,000 direct labour hours per period ;

The special order will require special tooling of Rs. 300 which is chargeable to the customer.

If the order received is for 100 or 200 units, the work will have to be done in period No. 8 which, for department F, is already loaded with 2,200 direct labour hours of work. Department G, however, will be working at only around 55% of capacity.

On special orders of this type, it is the company's practice to add the following margins on cost in arriving at selling prices :

	%
Department F	20
Department G	10
Direct materials	2
Sub-contractor's work (when used)	2

An outside sub-contractor has offered, irrespective of the size of the order, to do the work of department G on this order for a price of Rs. 8 per unit, including collection from and delivery to the works.

You are required to calculate :

- the price per unit of an order for 100 units if made entirely in the company ;
- the price per unit for an order of 200 units if made entirely in the company ;
- a separate price per unit for an extra 200 units subsequent to the order for 200 in (b) above, thus bringing the total order to 400 units ; (N.B. you are to assume that :
 - this additional order for the extra 200 units would be done when there are no capacity limitations in either department .
 - the materials supplier would give the full discount for the 400 units.)
- the change in unit selling price that would result from using the outside sub-contractor instead of department G for an order of :
 - 100 units
 - 200 units
 - 400 units.

(I C M A , Pt. III— Adapted)

ANSWER .

The costs and prices for 100, 200 and 400 units will be worked out as follows :

	100 units	200 units	400 units
	Rs.	Rs.	Rs.
Direct material	1,800	3,600	7,200
Less Discount	—	360	1,440
	1,800	3,240	5,760
Tooling	300	300	300
Direct labour and Overhead .			
Deptt. F (Rs. 2.50 + Rs. 1.00 + Rs. 3.50)	4,200		
600 hours		6,720	
960 hours (600 hrs. \times 2 \times 80%)			10,752
1,536 hours (600 hrs. \times 4 \times 80% \times 80%)		200	—
Overtime premium			

Deptt. G (Rs. 2+Rs. 1+Rs. 2)			
300 hours	1,500		
480 hours (300 hrs. $\times 2 \times 80\%$)		2,400	
768 hours (300 hrs. $\times 4 \times 80\% \times 80\%$)			3,840
Profit margin			
on direct material 2%	36	65	115
on Deptt. F costs 20%	840	1,384	2,150
on Deptt. G costs 10%	150	240	384
	<u>8,826</u>	<u>14,549</u>	<u>23,301</u>

(a) Price per unit Rs. 8,826/100 = Rs. 88.26

(b) Price per unit = Rs. 14,549/200 = Rs. 72.74

(c) Since the additional work would be done for 400 units (when extra 200 units are manufactured), when no capacity limitations exist in either department, no overtime would be involved. The managerial costs of the extra 200 units will, therefore, be .

Cost of 400 units Rs. 23,301

Less Cost of 200 units Rs. 14,549

Less overtime premium Rs. 200

Less Profit margin 40

(Deptt. F, 20% on 200) ———

Rs. 14,309

Rs. 8,992

Marginal cost of 200 units

Marginal cost per unit = Rs. 8,992/200 = Rs. 44.96

(d)

	100 units	200 units	400 units
	Rs.	Rs.	Rs.
Costs in Deptt. G	1,500	2,400	3,840
Margin 10%	150	240	384
	<u>1,650</u>	<u>2,640</u>	<u>4,224</u>
Less			
Sub-contract cost	800	1,600	3,200
Margin 2%	16	32	64
	<u>816</u>	<u>1,632</u>	<u>3,264</u>
Change (Saving)	834	1,008	960
Reduction in selling price per unit	Rs. 8.34	Rs. 5.04	Rs. 2.40

The above calculation is based on the assumption that the use of the sub-contract facility will not leave a part of the capacity of Deptt. G unutilised. If, however, the sub-contract work results in the creation of idle facility in Deptt. G, the reduction in the selling price will be as follows .

	100 units	200 units	400 units
	Rs.	Rs.	Rs.
Cost of idle facility :			
Unrecovered fixed cost at Rs. 2 per hour			
3 hours	6.00		
$3 \times 80\% = 2.4$ hours		4.80	
$2.4 \times 80\% = 1.92$ hours			3.84
Margin at 10%	60	48	38
	<u>6.60</u>	<u>5.28</u>	<u>4.22</u>
Change in selling price	Rs. 1.74	Rs. 0.24	Rs. 1.82
	(Reduction)	(Increase)	(Increase)
	(8.34 - 6.60)	(5.28 - 5.04)	(4.22 - 2.40)

INTRA-COMPANY TRANSFER PRICING

The problems of intra-company transfer (inter-unit, inter-process or internal transfer) arise when transfers of materials, work-in-process, finished goods, or services are made in two different types of situation, viz. (i) from one plant or factory to another under the same company, or (ii) from one division or sector of

a plant to another. In conventional accounting and in situations where control is centralised, transfers made from one department or division to another are made at actual costs. In case of an organisation in which control is decentralised, each division is recognised as a separate profit earning centre and the profit of each division is determined individually. Intra-company transfers are made frequently in such organisations, in the pricing of which consideration of the various factors involved is required to be made. The transfer price affects not only the profits of the supplier and the receiving divisions but has also an impact on the profitability of the company as a whole. If for instance, the transfer price is high, this will be at the cost of the receiving division whose profit will be reduced (or it may turn into a loss), whereas the supplying division will earn higher profit. Such a situation may lead to erroneous conclusions and may even set the management to seriously think about closing the losing division. In another case, one of the divisions may, in order to earn more profits, set its production target on a lower key, ultimately resulting in a reduction in the overall profit of the company. The apparent profit or loss of a division consequent to the development of a particular transfer pricing policy would also highly influence the company's decision to make or buy components or parts for its end products.

Let us consider a situation in which a Supplying Division, S of a company supplies components to its Receiving Division, R where these are processed into the end product for sale, one component being required for each unit of the product. The cost structures of the two divisions are :

S : Re. 1 per unit + Rs. 2,000 per period

R : Rs. 2.5 per unit (excluding cost of component) + Rs. 5,000 per period

The selling prices of the product for sales ranging from 500 units to 3,000 units in a period are as follows :—

Units	Selling price Rs.
500	12
1,000	11
1,500	10
2,000	9
2,500	8
3,000	7

If the transfer price of the component is fixed at Rs. 3 per unit, the position at different levels of production and sale may be summarised as in the following chart :—

Units	Division S			Division R				Company as a whole	
	Total Costs	Transfer revenue	Profit	Processing Cost	Total costs (Processing + components)	Sales revenue	Profit	Total costs	Profit
1	2	3	4	5	6	7	8	9	10
					(3 + 5)		(7 - 6)	(2 + 5)	(7 - 9)
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
500	2,500	1,500	(-)1,000	6,250	7,750	6,000	(-)1,750	8,750	(-)2,750
1,000	3,000	3,000	—	7,500	10,500	11,000	500	10,500	500
1,500	3,500	4,500	1,000	8,750	13,250	15,000	1,750	12,250	2,750
2,000	4,000	6,000	2,000	10,000	16,000	18,000	2,000	14,000	4,000
2,500	4,500	7,500	3,000	11,250	18,750	20,000	1,250	15,750	4,250
3,000	5,000	9,000	4,000	12,500	21,500	21,000	(-) 500	17,500	3,500

It will be seen from the above chart that while S would want to produce as many components as possible upto its maximum capacity, R would like to stop at 2,000 units level since any production and sale beyond that level would reduce the profit of the division. If the position of the company as a whole is considered, it will be seen that the level of 2,500 units gives the optimum profit and the company should fix its production at that level.

Taking another illustration, the impact of transfer price on make or buy decision may be seen. A supply division with a total capacity of 750 units of a component whose variable cost is Rs. 8 per unit, can sell outside only 500 units at Rs. 20 per unit. The requirement of this component by the receiving division of the company is 600 units which it can also obtain from an outside supplier at Rs. 18 per unit. If the transfer price is fixed at Rs. 20 per unit, i.e. at the selling price of the supplying division, the receiving division would prefer to purchase at the lower price of Rs. 18 available outside. But if the supplying division issues 250 components at the marginal cost of Rs. 8 per unit in consideration of the fact that its capacity beyond 500 units would otherwise remain unutilised, the receiving division will purchase only the balance requirement ($600 - 250 = 350$ units) from outside.

The *objectives* of transfer pricing are :

- (i) Current performance evaluation. Profitability is assessed individually in order to determine whether each division is competitive and can stand on its own.
- (ii) Assistance in decision making such as make or buy, sell a product as it is or process it further, and choosing between alternative production methods.
- (iii) Improvement of profit position. Each division is motivated to sell competitively so as to maximise its own profit and thus contribute to the overall profit of the business.
- (iv) Accurate estimation of the earnings on proposed investment decisions. This is particularly useful when finance is scarce and allocation of the scarce resources is to be determined between the competing claims from the various divisions of the concern.

In the case of multi-national companies operating in more than one country, the degree of inflation, extent of fluctuations in exchange rates and different tax laws in the various countries of operation influence the transfer price policy. Transfers are made at higher prices with the object of minimising risks and withdrawing funds from the transferee country if that country (i) has a high inflation in exchange rates, or (ii) has imposed restrictions on fund transfers to foreign countries. On the other hand, transfers on low prices may be made as a price subsidy with a view to (i) get a foot hold in competitive foreign market or to meet increased foreign competition, or (ii) obtain higher profits in 'tax haven' transferee countries where the tax rates are lower.

The various methods of transfer pricing in use, are discussed below.

1. *Total cost method* : Under this method, transfers are priced at full absorption cost which may be the actual cost or standard cost. In the latter case, unfavourable variances caused due to inefficiencies are not transferred to the consignee but remain charged to the consignor.

The method is the same as followed in conventional financial accounting and it obviates the problem of adjusting the closing stock for intra-company profits.

The total cost method has the following *limitations* :—

- (i) This is not suitable for performance evaluation of individual units as the profitability of each unit cannot be correctly determined. This problem will not, however, arise if the responsibility for achieving profit is centralised and individual sectors are not to be held responsible for it.
- (ii) This may lead to a wrong decision being taken, particularly in the case of consignee unit.
- (iii) Transfer at total cost without the addition of any profit element may mean that the profit of the consignor is understated while that of the consignee is overstated.
- (iv) The total cost would include administration and marketing expenses. The extent of these expenses incurred for intra-company transfers may not, however, be on the same scale as for external sales. It is for this reason that intra-company transfers are sometimes made at total cost of manufacture exclusive of administration and marketing expenses.

2. *Marginal cost method*: In this method, the transfers are made at variable costs. As fixed costs do not come into the picture, this method is very useful for making short-term decisions. It, however, suffers from the following *disadvantages* :—

- (i) The method works adversely for the consignor department which is not allowed to recover not only the profits but the fixed costs as well from the transfer transaction. Performance evaluations of both the consignor and the consignee are thus vitiated.
- (ii) Where the absorption system of costing is adopted, adjustment of the stock of work-in-progress and finished goods is required on account of the fixed overhead which is excluded from the transfer. This difficulty will not, however, arise if the accounts of the concern are maintained on marginal cost basis.

3. *Total cost plus a percentage of profit method* : In this method, which is also known as *total cost plus a mark-up or full cost plus method*, a suitable specified percentage of profit is added to the cost of transfer. The percentage or mark-up may be added either to the total cost or to the marginal cost. In the former case, the percentage would be such as to get an agreed profit, while in the latter case, the percentage will be high enough to earn the profit and also recover the fixed cost.

The method may be conveniently used where the market price is not readily available. The mark-up to be added would vary widely but one suitable method is to link it with the return on investment. In other words, the transfer price should be so fixed as to yield a specified return on the capital invested. Let us assume, for example, that 5,000 units of a product manufactured annually by a plant costing Rs. 10,000 are transferred to another unit and that the rate of return on the capital is expected to be 20% per annum. If the cost of the units transferred be Rs. 5 each, the transfer price will be,

$$\text{Rs. } 5 + \frac{\text{Rs. } 10,000}{5,000} \times 20\% = \text{Rs. } 5.4 \text{ per unit.}$$

The cost-plus method of transfer pricing has the following *disadvantages* :—

- (i) Difficulty in determining a reasonable profit margin or a fair return on the capital invested makes the method largely arbitrary.
- (ii) A predetermined rate guarantees an estimated profit to the consignor division. Thus, the performance of that division cannot be effectively measured unless a comparison is made with the market price (if any) or standard price.
- (iii) If the consignor division is working below capacity or is inefficient, the resulting high cost and also the high profit added thereon are passed on to the consignee. Similarly, the benefits of any reduction in costs or savings achieved are also shared. This makes the evaluation of performance difficult unless here again, it is possible to compare with the market price.

4. *Market price method* : Market price, wherever available, may be adopted for pricing intra-company transfers. This is a rational method which is based on the principles of opportunity cost. The consignee receives the product at the price which it would have paid if purchased from outside ; for the consignor, market price represents the earnings which it has lost by the transfer.

The method offers the following *advantages* :—

- (i) The consignor gets a fair reward and an incentive for efficient production.
- (ii) The efficiency or inefficiency of the consignor does not come into play and so it does not affect the consignee.
- (iii) The consignee division is left in the same position as it would have been had the consignor division not existed.
- (iv) No time is lost in bargaining and there are no disputes about transfer prices.

The market price method presents the under mentioned *difficulties* :—

- (i) Difficulty in obtaining market price. In many cases, there may not be any market for the product which is manufactured only for captive (internal) consumption.
- (ii) Market price consists of elements of selling and distribution expenses such as commission, discounts, advertisement and sales promotion, bad debts, credit collection and warehouse cost (if the product is transferred direct from the shops without passing through the warehouse). Though suitable adjustment may be made by deducting these expenses from the market price, correct allocation of such expenses to product costs is difficult.
- (iii) Adjustment in closing stock is required to be made for the profit included.
- (iv) When prices are unstable, the evaluation of performance is vitiated due to too frequent changes in the transfer pricing.
- (v) Market price depends upon various external factors and as such, proper evaluation of performance cannot be made.
- (vi) The product may not be completely and fully comparable with the product in the market, e.g. due to difference in size, quality etc. The market price adopted in such circumstances may not, therefore, be suitable.

5. Negotiated or bargained price method : Under this method, the transfer price is negotiated between the consignor and the consignee departments, as if the two were independent undertakings trying to make the best of the bargain. The consignee department obtains quotations from the consignor as well as from external suppliers. A decision is then taken whether to purchase from outside or to obtain internally, keeping in view the marginal cost of the product and the capacity available for its manufacture.

The limitations of this method are:—

- (i) Non-availability of suitable price quotations from outside sources.
- (ii) Quotations may not be reliable. Sometimes suppliers deliberately under-quote in order to capture the market and to procure business.
- (iii) The transfer price is dependent not only on the productive ability but also on the negotiating ability of the departmental manager.

It may be noted that when the transfer price is less than the total cost the supplier division is at a disadvantage in so far as its profit earning is concerned. To motivate the division, therefore, a system of dual pricing is adopted for the purpose of performance valuation. While the transfer to the receiving division is made at a price lower than the total cost, the supplying division is given credit for the transfer at total cost in the performance report.

An example illustrating a case on intra-company pricing is given below.

EXAMPLE 17.3.

The relevant data for a period in respect of one of the Divisions of an enterprise, manufacturing a single product, are as follows :—

Product cost	
Variable	Rs. 2 per unit
Fixed	Rs. 80,000
Assets	
Working capital	Rs. 1,00,000
Fixed assets	Rs. 2,00,000
	Rs. 3,00,000

The desired rate of return on the capital employed by the enterprise is 30%, and the Divisional Manager has fixed the selling price of the product at Rs. 2.5 per unit.

- (i) Calculate the number of units which the Division should produce and sell in order to achieve the target return.
- (ii) The product is also usable as raw material in another Division of the same enterprise. It is proposed that out of the total units manufactured as at (i) above, 60,000 units be transferred to the other Division. The transfer price is a subject of discussion between the two Divisional Managers. The transferee is insisting that the price be fixed at Rs. 2.3 per unit, which is the price at which it can be procured from the market outside. On the other hand, the transferor states that if no transfer is made and production is curtailed accordingly, there will be a reduction in the working capital, fixed assets and fixed cost to the extent of Rs. 10,000 each. You are required to give your comments regarding the proposed transfer price of Rs. 2.3 per unit.
- (iii) In case it is agreed that the transfer to the other Division be made at a price of Rs. 2.3 per unit, at what price should the transferor sell the remaining units so as to maintain the desired return of 30%? Alternatively, how many more units should it produce assuming that this will not entail any change in the fixed cost, the asset cost or the selling price.

(I.C.W.A., Final)

ANSWER :

- (i) Target return—30% of Rs. 3,00,000 = Rs. 90,000
 Contribution per unit = Rs. 2.50—Rs. 2.00 = Re 0.50
 Total contribution required = Rs. 90,000 ÷ Rs. 0.50 = Rs. 1,70,000

$$\text{Units required to be produced} = \frac{1,70,000}{0.50} = 3,40,000$$

- (ii) If 60,000 units are transferred at Rs. 2.3 per unit, reduction in profit—(Rs. 2.5—Rs. 2.3) × 60,000 = Rs. 12,000

$$\text{Return on capital} = \frac{\text{Rs. 90,000} - \text{Rs. 12,000}}{\text{Rs. 3,00,000}} = 26\%$$

i.e. a reduction of 4% from the target return of 30%.

But when production is restricted to 3,40,000—60,000 = 2,80,000

$$\text{Cost} = \text{Rs. } 2 \times 2,80,000 = \text{Rs. } 5,60,000$$

$$\text{Sale value} = 2,80,000 \times \text{Rs. } 2.50 = \text{Rs. } 7,00,000$$

$$\text{Reduction in profit} = \text{Rs. } 90,000 - (\text{Rs. } 7,00,000 - \text{Rs. } 5,60,000) = \text{Rs. } 20,000$$

$$\text{Return on capital} = \frac{\text{Rs. } 70,000}{\text{Rs. } 2,80,000} = 25\%$$

Thus curtailment of production will result in a net loss of Rs. 8,000 (Rs. 20,000—Rs. 12,000) for the transferor department and a further reduction of 1% in the return on capital. It would, therefore, be of mutual advantage for the two departments to accept the transfer at Rs. 2.3 per unit

[Part (iii) of the problem has not been answered, being not relevant to the topic under discussion]

PRICE QUOTATION

Estimates of costs and prices are required for bidding for contracts or for offering quotations of prices in respect of a job to be undertaken for a customer. Such jobs or products to be manufactured may be (i) products of specialised or non-standard types, mostly to customer's specifications for which no established market prices are available, or (ii) products which are mass manufactured against stock orders in anticipation of demands. Extreme care is necessary in the preparation of cost estimates; too high a quotation may result in loss of business, whereas estimates on the lower side may lead to reduced profits or even losses.

In a concern manufacturing largely to customers' specifications, there will usually be a separate department responsible for dealing with cost estimating. This department, which specialises in the technique of cost estimating, functions in close co-operation with the other departments such as Sales, Planning, and Production departments. On receipt of an enquiry, which generally comes through the Sales department, it is to be seen firstly, whether sufficient know-how and machine facilities exist to enable manufacture to be undertaken and, secondly, whether machine capacity is available for the quantum of work to be done. All these information would be obtained from the Planning department. When capacity is limited or where other limitations like materials shortage, labour shortage, etc. exist, it is to be seen whether the position can be improved. It will also be considered whether other products would, with the existing constraints, give more profit, in which case it may not be worthwhile proceeding further with the quotation enquiry.

After a decision is taken to entertain the enquiry, the next step is to prepare drawings, blue-prints, and designs of the products to be manufactured. The

enquiry is processed through the Planning, Design, and Production departments and a co-ordinated decision is taken on the following points :—

- (a) Any modification necessary with a view to cost reduction.
- (b) Preparation of details of parts and components to be manufactured or to be purchased.
- (c) Technical assessment of the requirement of the various raw materials and the minimum quantity of each. Allowances for normal wastage and losses should also be estimated. All these details should be incorporated in the bill of materials.
- (d) Requirements of tools, jigs and fixtures.
- (e) Preparation of operations schedule indicating operation sequence, machine time, labour time, grade of workers, etc. This also helps to assess the various grades of skilled workers required for the job.

Estimates are then prepared showing the costs of materials, labour, other direct charges, and overhead (see Fig. 17.1). Where cost of identical or similar jobs undertaken in the past is available, the historical data may be adopted after making suitable adjustments with reference to the current and anticipated costs. When past data are not available, cost estimates are built up 'synthetically' in the manner indicated below :

Materials : As mentioned above, the quantities of the various materials required are incorporated in the bill of materials. These are valued under any of the methods of stores pricing such as Lifo, Fifo, average rate, market price, replacement price, or rate contract price, as the case may be. Future price trends are also kept in view and the price is suitably adjusted to take care of any likely heavy rise or fall. The effect of sharp fluctuations may however, be obviated either by entering into forward purchase contracts or by inclusion of an escalator clause.

Labour : Labour requirements are laid down in the operations schedule. When converted in terms of money, these give the labour cost. The labour cost should, if necessary, include fringe benefits, overtime premiums, and training costs. Where piece-work or other incentive systems are in use, estimation of labour cost is simpler. Escalator clause may also be stipulated in the estimates, as in the case of materials.

Other direct charges : These include costs of designs, jigs, tools, and fixtures, payment of royalties and patent rights, packing, transportation, insurance, commission and discount, hire charges for plants and equipment, and the cost of after-sales services, if any. Preliminary design, special tools, jigs, etc., present a problem because if charged in full, these would inflate the cost of the job and thus involve the risk of loss of the order. If repeat orders are expected which may absorb the residual costs of these equipments, only the proportionate costs should be charged to the job under consideration.

Overhead costs : Factory overhead is added on the basis of the method of recovery of overhead in vogue in the concern. The inclusion of administration, selling and distribution overhead and the extent thereof will depend largely on the policy of the management and the market conditions for the product under consideration. Another important consideration in the determination of overhead rate for the purpose of estimating is the level of future activity on which the rate

should be based. The capacity at which a business is operating and the normal capacity as defined by the management for recovery of overhead cost, influence the estimated costs. The special features of the methods of determination of overhead rates based on various capacity levels were discussed in Chapter 4. It is to be noted that application of an overhead rate based on the operating capacity may result in understating the estimated cost with the inherent danger of incurring loss on undertaking the order. If, however, the cost of idle capacity is included in the overhead rate by adopting the sales expectancy capacity as the normal capacity, the high cost may result in loss of the order. In all these considerations of capacity, as also if prices are to be based on marginal costs, the distinction between fixed and variable overhead should be clearly recognised.

On the basis of the estimates prepared on the above lines, the management decides upon the price to be quoted. Price is dependent on a large number of factors and cost estimating is only one facet of the problem of price quotation. In fact, pricing involves more of judgement than computation. The inter-play of all the factors should be carefully considered and a reasonable price quoted which should not be very high nor very low, so as to attract the order and at the same time, ensure a suitable margin of profit for the concern.

Some special considerations apply when estimates of costs are being prepared for the *export market*. Some of these result in increase in costs, while the rest have the effect of reducing costs. These considerations are :

Increase in cost

- (i) Special packing to withstand handling in transit by sea or air.
- (ii) Additional costs on transportation, port charges, custom duties, commission, and insurance.
- (iii) Increased quality costs. These are necessary to ensure the quality of the products exported so as to retain goodwill in the foreign market. Quality is maintained by a high standard of manufacture combined with a strict system of inspection. Sometimes, the specifications and standards laid down by the Government are to be followed.
- (iv) Costs of market exploration, such as market research, foreign marketing centres, representatives, fairs, exhibition etc.

Reduction in cost

- (i) Concessions given by the Government, e.g. subsidies for particular items or class of manufacturer, exemption or reduction in excise duty, and liberal customs duty or exemption therefrom in respect of the imported raw material content of the exported product.
- (ii) Selling and distribution costs incurred for home sales are not added to export costs. Cost of special sales promotion for export should, however, be added.
- (iii) Increased utilization of capacity.

Normally the importer pays in the currency of his country and the exporter gets the equivalent in rupees. Thus the exporter stands to gain or lose according as the rupee equivalent of the foreign currency as on the date of quotation goes up or falls on the date of actual payment of the bill.

Products may sometimes be sold to foreign countries at a *price below costs* in order to establish market. This may be possible under the following circumstances :-

- (i) If there is a large home market and the price in the home market is sufficiently high so that even after setting off the resulting loss in foreign market, there is a reasonable return.
- (ii) If losses are subsidised partially or wholly by the Government in order to boost export.
- (iii) When several inter-linked products are manufactured, the loss on the export of a product may not matter much if the other products yield high profits. Obviously, export oriented enterprises whose entire production is sold in the foreign market cannot afford to sell all their products below costs or even at marginal cost on a long term basis.
- (iv) A concern working below its capacity may accept an export price below the marginal cost if the export enables it to get 'import entitlement' on the basis of the foreign exchange earned or under a barter agreement. The concern may be allowed to import materials and spares which it badly needs to step up production, in which case, the profits in the home market arising out of the increased sales compensate the loss incurred on the export.

The final stage in the procedure for quoting price is the preparation of tenders. Though no standard form of a tender suitable for all concerns can be laid down, the contents will be broadly on the following lines : --

- (i) Particulars and specifications of jobs or products. Drawings, where required, should be attached to the tenders.
- (ii) Price and ancillary charges such as sales tax, duties, etc.
- (iii) Mode of transport and cost of transportation (unless delivery is to be made free).
- (iv) Terms of payment including a penalty clause for delayed payment.
- (v) Date of delivery of completion and protective clause for non-adherence to that date or extension of delivery period under specified circumstances.
- (vi) Terms of replacement and rectification of defective work.
- (vii) Clause for use of substitute material.
- (viii) Suitable escalator clauses, as necessary.
- (ix) After-sales services offered.

To safeguard against errors in estimating costs and tendering, the estimates should be checked and reviewed by someone other than the person responsible for its preparation. If estimates of similar jobs were prepared or such jobs undertaken in the past, a procedure for comparison with past estimates or actual costs may provide a suitable second check. Where possible, a snap check up with a rough or short-cut estimate may also prove useful.

EXAMINATION QUESTIONS

1. Describe the factors taken into consideration in fixing the selling price under a normal condition and in a competitive economy. There is no constraint in regard to the availability of raw materials, labour or power. (I.C.W.A., Final)

2. (a) What is the relation between cost and price?
(b) Comment on the following bases for pricing :
(i) Total unit cost
(ii) Return on capital employed
(iii) Marginal income approach
(I.C.W.A., Final)
3. Making a profit is not a sin. It is essential for the sustenance of the business, nay for the entire economic structure and its economical growth. Discuss what recommendations you can make as a cost accountant on the profit margin to be allowed in fixing the selling price.
You may assume necessary figures.
(I.C.W.A., Final)
4. Explain fully the steps that are followed in pricing a product. Do you agree that "Penetration-pricing" is a more aggressive competitive strategy than "Skim-the-cream pricing"? Give reasons for your answer, together with cogent illustrations.
(I.C.W.A., Final)
5. How might a company's pricing strategies differ depending on whether a product is in the pioneering stage or maturity stage of its life cycle?
(I.C.W.A., Mgt. Accountancy)
6. "In the long term, price will tend to equal costs plus reasonable profits." Discuss with reference to interplay of demand and supply on profit.
(I.C.W.A., Final)
7. A company which believes in Scientific Management wants to streamline its pricing policies and with this end in view wants you to do an audit of the present pricing policies of the company. Explain broadly outline how you will approach the problem.
(I.C.W.A., Final)
8. An Automobile Manufacturing Company has its own Foundry Forging Divisions which supply not only the requirements of casting and forgings for automobile produced, but also sell a part of their production to outsiders. The products of these divisions are charged to the automobile division at cost plus 20% profit. Comment on this method of pricing. Would the performance of these divisions be judged by their profitabilities?
(I.C.W.A., Final)
9. Discuss briefly three bases normally followed in pricing interdepartmental transfers of products. Indicate the most suitable method to perform the evaluation of departments.
(I.C.W.A., Final)
10. Tabulate various methods of transferring finished products of one plant to another under the same Management for internal control. Illustrate each method with examples.
(I.C.W.A., Final)
11. (a) Do you consider as absolutely essential that inter-company transfers should be priced for assessment of managerial efficiency of each production division of a company? Discuss the different methods of pricing and their advantages, if any.
(b) An Automobile manufacturing company finds that while the cost of making in its own workshop Part No. 0025 is Rs. 6.00 each, the same is available in the market at Rs. 5.60 with assurance of continuous supply. Write a report to the Managing Director giving your views whether to make or buy this part. Give also your views in each case if the suppliers reduce their price from Rs. 5.60 to Rs. 4.60. The cost data are as follows:

	Rs.
Materials	2.00
Direct labour	2.50
Other variable cost	0.50
Depreciation and other fixed costs	1.00
	6.00

(I.C.W.A., Final)
12. Explain fully, with suitable illustrations, the base for fixing prices for intra-company transfers in a decentralised organisation.
(I.C.W.A., Mgt. Accountancy)
13. Enumerate the various methods by which one division of a Company can price its sales to another division of the same Company. Each division is treated as a profit centre.
(I.C.W.A., Final)

14. Decentralisation can be made more effective by controls like institutions of profit centres and competitive transfer prices. Critically examine this statement and discuss fully how far these techniques may be usefully applied in manufacturing industries in India. (ICWA, Mgt Accountancy)
15. With the growth of organisation as well as geographical extension, it becomes necessary to divisionalise the activities. In order to have an overall control on the performance of each division, the return on capital employed by each division is taken as a measure. When there are inter-division transfers of products and services, it becomes essential to assign a price for these transfers to evaluate the performance of each division.

List the various methods used for pricing and as management auditor state the circumstances under which each method could be used. (ICWA Final)

16. The operating results of an industrial concern for the year ending June, 1967, were as follows —

Product	Unit	Sale		Cost of production		
		Rate Rs	Amount Rs	Unit	Rate Rs	Amount Rs
A	20,000	10	2,00,000	20,000	5	1,00,000
B	50,000	5	2,50,000	50,000	4	2,00,000
C	10,000	20	6,00,000	10,000	14	4,20,000

It is proposed to change the volume and mix of sales and production as follows:

A — 50,000 units

B — 80,000 units

C — 10,000 units

Calculate the effect of the proposal in profit making on the assumption that cost of production and selling price for each type remains the same. (ICWA Final)

17. A large engineering company accepts order to fabrication of machine parts, general castings, and structural material of varying sizes ranging in sale value from Rs. 100 per piece to as high as Rs. 1,00,000 per piece. They are perturbed by the rapid increase in raw material costs which is 75% of their total cost for almost all products, and labour forming nearly 15% of total cost, and loss of production hours due to lack of electric power. The sales manager suggests that he has made a detailed study of the variations of past three years and finds that the rate of increase of various factors per year is as below:

	Per Year
Raw material price increase	8%
Transport cost increase	3%
Labour wage increase	15%
Loss of production hours	10%
Overhead expenses increase	6%

He suggests that the production engineers should estimate the duration of an order and the cost accountant estimate the cost including the increases at the above rate for the duration of the order. The managing director feels that this is an useful idea as it at least minimizes the loss they would otherwise sustain. Do you concur?

Write a note to the Managing Director, with a copy to the sales manager and the production engineer of your suggestions which can be considered for adoption at a joint meeting to be held very shortly. Give specific actionable suggestions only, indicating the limitations, if any, and its extent. (ICWA Final)

18. Jame & Co Ltd manufactures one standard product. The standard cost per unit is as follows:

	Rs
Direct material	16
Direct labour	8
Variable overhead	6
	<hr/>
	30

Budgeted output for the year is 10,000 units and the fixed overhead is computed at Rs. 1,50,000. It is the policy of the company to assess profit at 33½% of the cost price.

The following is the projected Balance Sheet of the company for the year.

Liabilities		Assets	
	Rs./lakhs		Rs./lakhs
Share Capital	7.00	Fixed assets	
Profit & Loss A/c	0.50	Less Depreciation	6.80
Creditors	0.20	Current assets	0.90
	—		—
	7.70		7.70
	—		—

You are required to calculate the return on investment and comment critically on the profitability of the company together with your suggestions, if any.

19. On June 30, 1970, a perambulator manufacturer desires to quote for a contract for the supply of 5,000 perambulators. From the following data, prepare a statement showing the price to be quoted to give the same percentage of the profit on turnover as was realized during six months to May 31, 1970 :

	Rs.
Stock of materials (opening stock)	1,00,000
Stock of materials (as on 31.5.70)	14,000
Purchases of materials (6 months)	1,50,000
Direct wages	3,00,000
Overheads	50,000
Sales	5,40,000
Completed stock in hand (opening)	Nil
Completed stock in hand (as on 31.5.70)	1,00,000

The number of perambulators, manufactured during the 6 months, was 6,000 including those sold and those in stock at the close of the period. The perambulators to be quoted are of uniform size and quality and similar to those manufactured during the previous 6 months. As from 1.4.70 the cost of direct labour increased by 20 per cent. (I.C.W.A., Final)

20. A factory has two production departments, each making a different product. No cost accounts are kept, but a system of cost estimation for issuing quotations is in vogue. Quotations are prepared on the broad assumption that the two products involve in terms of monetary cost equal amounts of direct labour and direct material. A consolidated overhead of 150 per cent on direct labour cost is applied to derive the factory cost : 15 per cent is added to the factory cost to cover all other overheads, and to determine the total cost. 15 per cent on the total cost derived is included to cover the profit margin. On the above basis, quotations to the value of Rs. 9,25,750 were issued in respect of a month's production. The expenses attributable to the month in question were :

Direct Material	Rs. 2,10,000
Direct Labour	Rs. 2,40,000
Factory Overheads	Rs. 4,00,000
Selling Overheads	Rs. 30,000
Distribution Overheads	Rs. 20,000
Administration Overheads	Rs. 50,000

The management are perturbed about their loss and need advice to fix selling prices, taking into consideration a complaint that one of their products is available from a competitor at a lower price. They do not wish to invest on an intricate cost accounting system involving the introduction of additional staff. As a cost consultant what will you advise the firm ? (I.C.W.A., Final)

21. It has been the practice in the engineering department of a factory to submit quotations and estimates direct to the sales department for fixation of final selling prices by adding a certain percentage on the prime cost to cover overhead and profit. On your taking up the

appointment as Cost Accountant, the procedure is changed and estimates are routed through the cost department. Scrutinize the following estimates relating to a product and submit a report to the management indicating revised estimated costs of the product based on previous year's accounts and calculate revised selling price after allowing 15 per cent profit on the total cost.

Estimated .	Rs.
Materials	25,000
Labour 30 hours, Rs. 1.50 per hour	
Deptt. X 20 hours	
Deptt. Y — 10 hours	45 00
	— —
	70 00
Add 50 per cent on prime cost	35 00
	— —
Total	105 00
	— —

Data from the previous year's accounts —

	Rs
Consumption of material	50,000
Direct wages	60,000
Factory overhead	35,000
Selling, distribution and other administrative charges	29,000
Profit	26,000
	2,00,000

(I C W A , Final)

22. The prices of different raw materials have registered a decline while the wages rates have gone up. The Company wants to pass on the saving to the consumers. From the following data work out (i) revised selling prices, (ii) revised profit, and (iii) revised profitability under each of the following plans. Ignore fluctuation in sales volume and incidence of overheads.

Plant 'A' — Net saving in cost to be passed on

'B' — 90% of the saving in the cost of raw materials less 90% of the increase in labour cost, to be passed on.

'C' — 80% of the saving in the cost of raw materials to be passed on

Particulars		Product X	Product Y	Product Z
(1) Current selling price per unit		Rs. 10.00	Rs. 12.00	Rs. 15.00
(2) Current profit per unit		„ 1.50	„ 1.20	„ 2.25
(3) Consumption of raw materials per 10 units				
Raw Material	A	15 Kg	20 Kg	40 Kg
	B	10 „	5 „	5 „
	C	5 „	6 „	5 „
	D	20 „	15 „	15 „
(4) Labour hours per 100 units		25 hrs	19 hrs.	29 hrs.
(5) Reduction in the prices of raw materials :				
Raw Material A — Re. 0.90 per Kg.				
B — Re. 1.25 „				
C — Re. 0.50 „				
D — Re. 0.25 „				

(6) Increase in wage rate — Re. 0.25 per labour hour

(I C W A., Final)

23. X Ltd. has two operating divisions, each of which is a profit-centre. Division A transfers part of its production to Division B at the same price at which it sells to the open market. This is to facilitate divisional performance evaluation. However at the end of each period, the closing

of accounts of X Ltd. involves considerable complications because of the transfer price. Given below are the summarised stock accounts of division B for three periods :

	(Rs. '000)		
	Transfer from Division A	Purchase from Outside	Total
Period 1			
Opening Stock	600	300	900
Purchases	500	100	600
	<u>1100</u>	<u>400</u>	<u>1500</u>
Consumption	750	150	900
Period 2			
Opening Stock	350	250	600
Purchases	580	290	870
	<u>930</u>	<u>540</u>	<u>1470</u>
Consumption	400	500	900
Period 3			
Opening Stock	530	40	570
Purchases	500	300	800
	<u>1030</u>	<u>340</u>	<u>1370</u>
Consumption	400	270	670
Closing Stock	<u>630</u>	<u>70</u>	<u>700</u>

The transfer prices of Division A included profit at the following rates.

Prior to Period 1	Nil
In Period 1	15%
" 2	20%
" 3	25%

Calculate the inter-divisional profits to be eliminated from the Stocks of Division B at the end of Period 1, 2 and 3. (I.C.W.A., Final)

24. GTM Ltd. consists of three departments, grinding, turning and milling, all of which have the same productive capacity. The overheads budget for the next cost period of 1,000 machine hours capacity for each department is as follows :

	Fixed Costs	Directly Variable cost per Machine Hour
	Rs.	Rs.
Grinding	20,000	2.50
Turning	10,000	2.00
Milling	7,500	3.75

The Company wish to participate in a tender in which there are three contracts X, Y & Z. However as per the tender term, contracts Y and Z have to be offered as a package and GTM Ltd. feels that it would not offer the package unless it is as profitable as contract X, since capacity can be utilized elsewhere.

The Works Manager has studied the specifications relating to these three contracts and has worked out the following details :

	Contract X	Contract Y	Contract Z
	Rs.	Rs.	Rs.
Direct Material Costs	18,000	16,100	12,400
Direct Labour Costs (rate per hour) which differ due to skills involved :			
Grinding	3.00	2.50	4.50
Turning	2.00	2.50	4.00
Milling	1.50	2.00	2.25
Use of capacity (in machine hours)			
Grinding	660	400	400
Turning	760	500	420
Milling	864	400	320

It will be necessary to employ 3 men in each department for the number of hours during which machine facilities are used in the work in respect of each of the three contracts. You are required to compute :

- (a) A comparative statement showing the minimum amount at which the firm could afford to accept the contracts.
- (b) If atleast one man (included under direct labour) has to be employed in each department regardless of the level of activity, indicate the amendment to your computation in (a).
- (c) Assuming that tenders would be accepted if GMT Ltd. quoted the following prices for the contracts : X Rs. 41,000, Y Rs. 32,000 and Z Rs. 26,500, advise the firm what he should do concerning the contracts to be accepted under the conditions (a) & (b) above.
(I.C.W.A., Final)

25. Excel Engineers Ltd. manufacture components, sub-assemblies and assemblies of automobile parts. The Company is divided into Divisions and each Division is treated as a Profit Centre and Transfer Pricing for transfer between Divisions is in operation.

The components Division (C) is working at full capacity and is selling the various components it manufactures profitably to regular customers. The Sub-Assembly Division (S) which is operating now at 60% capacity has a very large prestigious order for sub-assembly SA 44 from Speed Cars Ltd. who have offered to pay Rs. 75 a piece. This is the first time that Excel Engineers have an order from Speed Cars Ltd. and S is very keen to execute this order and improve its profitability.

SA 44 requires a set of 5 components manufactured and sold by C to its regular customers at Rs. 4 per unit.

S prepared an analysis of the probable costs and worked backward from the selling prices to determine the amount it could pay per unit to C

Proposed Selling Price		Rs. 75
Components purchased from outside suppliers	27.50	
Testing charges	4.00	
Assembly expenses and Variable overheads	13.50	
Fixed Overhead allocation	15.00	
Project Margin	5.00	65

Amount which can be paid to C for a set of
5 components per unit @ Rs. 2 per unit

As a result of this analysis the Sub-Assembly Division asked the C Division to supply the required components at Rs. 2 per unit to which C did not agree as they had already an assumed market outside at Rs. 4 per unit.

As S is not able to procure its requirement in the outside market and it has to get the components from C only for executing the order from Speed Motors, Management asks you as a Cost Accountant of the Company to fix a fair Transfer Price. You find that Rs. 2.80 would cover the full cost including fixed overhead and variable cost of Rs. 1.50 per unit of component and Rs. 3.50 would provide a gross margin equal to the average gross margin on all of the products sold by Excel Engineers Ltd. Write a memorandum to both the Divisions C and S with proper arguments to convince them that Rs. 3.50 per unit of component would be a fair Transfer Price in every one's interest.
(I.C.W.A., Final)

CHAPTER 18

SOME SPECIAL TOPICS

The following topics and techniques are discussed in this Chapter :—

Value Analysis

Learning Curve

Cost Reduction

Human Resource Accounting

Productivity

Inflation Accounting

Management by Objectives

VALUE ANALYSIS

Value analysis or value engineering, as it is also called, is one of the several specialised services offered as tools of management. It may be defined as a systematic analysis and evaluation of the techniques and functions in the various spheres of an organisation with a view to exploring channels of performance improvement so that the value in a particular product can be bettered. Value analysis aims at cost reduction from the point of view of value. The commonly used cost reduction techniques reduce costs by economising expenditure and increasing productivity, whereas value analysis probes into economic attributes of value. The concept of value analysis is that for a continuous process of planned action, it is possible to improve performance and increase the value in a product and thereby reduce costs.

The terminologies of value analysis and value engineering are often used interchangeably as both have many identical steps in their working procedure. Yet, the fundamental difference between the two arises due to their areas of application. While value analysis can be applied to any kind of cost, value engineering is applied mainly to direct costs, i.e. direct material, direct labour etc. Value engineering is generally used before a product is born and is in the design and development stage and value analysis is applied to products already being marketed and its necessity arises due to dropping sales. Thus costs subjected to value analysis may require the application of value engineering. In this text, the term value analysis has been used throughout since the primary objective is to discuss here the methodology of the technique.

In order to understand the principles and procedure of value analysis, it is essential to know which are the various types of value. The term, value is used in a wide sense and it has different meanings for different persons, and at different times and places. Thus for a designer, value means quality of the product designed ; for the salesman it means the price which it can fetch in the market ; and

for the top management, value would be the return on capital invested. An industrial product may have four types of value :

- (i) *Use value* : There are certain characteristics and features that make a product useful so that it can give useful service for which it is intended. A watch, for example, is meant to indicate time ; if it gives correct time, it gives its full value. Use value is the measure of the quality of performance of a product. Use value may be classified into three categories, viz. (i) Primary use value, (ii) Secondary use value, and (iii) Auxiliary use value. The attributes of a product which are essential for its performance may be categorised as having primary use value. In a motor car, for instance, the engine and the other driving contrivances like the steering wheel or the axle may be considered to be of primary use value because in their absence the car cannot be made to run. The bonnet or the mudguards or the windscreen are also necessities for protection of the engine and other parts but the car can be driven even without these. Such items have secondary use value. Items like speed meter or mile meter, fuel meter etc., which are required for better control and operation but are not very essential, may be classified as having auxiliary use value.
- (ii) *Esteem value* : Certain properties do not contribute to the utility or performance of a product but they make it attractive or esteemable which would induce customers to buy. A watch made of gold has esteem value. A discerning buyer may prefer a gold watch for its appealing look although a similar watch made of steel could serve the purpose of keeping time equally well.

Certain attributes of a product may have use as well as esteem value both of which may be important. A fountain pen with a gold plated body or a piece of highly polished furniture or a nickel plated cycle rim or handle will not only look better but will also last longer, thus combining esteem value with use value.

- (iii) *Cost value* : This is value measured in terms of cost. Cost value is the total cost required to produce an item. In the case of manufactured items, it refers to the cost of production and if obtained from outside, it means cost of purchase.
- (iv) *Exchange value* : Certain properties of a product facilitate its exchange for something else. The exchange value of a product is equivalent to its sale value.

Value analysis mainly refers to the use value (here too, value analysis is mostly applied to secondary and auxiliary use values) and to some extent to the esteem value. Cost and exchange values are not much relevant to industrial situations. For example, any inefficiency in labour or waste of material increases costs but does not add to the value of a product. In the restricted sense, value may, therefore, be considered as the least amount of money which should be spent for creating the use and esteem factors of a product.

Procedure of Value Analysis. The meaning and purpose of value analysis can best be appreciated by considering the various basic steps essential for putting a scheme of value analysis in operation. These are :

- (i) *Identification and definition of the problem* : It will be necessary to ascertain whether the customer is being given the full use value and esteem value for the product he buys and if not, what does he need and what is required to be accomplished. In the case of raw materials and components, the question asked would be whether they give performance satisfaction in subsequent production or processes.
- (ii) *Collecting information* : Each item of a product or process is taken up, its function is considered and all background information and relevant facts like drawings and design, tolerances, material specification, material, labour, overhead and other costs, market, competitive products etc. are obtained before proceeding further with the job of value analysis.
- (iii) *Exploring and evaluating alternatives* : All potential value alternatives are to be thought of and the cost of each alternative determined to explore the best method of performing the work at the minimum cost. This would involve a continuous search for utilisation of alternative or substitute materials, components, and processes so as to better the performance.
- (iv) *Development and planning* : The effective value alternatives are then tested by experiments and trial runs in order to find out the most satisfactory solution to the problem.
- (v) *Recommendation of the final proposal for implementation* ; Some of the questions which would be asked and satisfactorily answered at this and the previous stages are given below, by way of illustration. Obviously, no standard list or questionnaire can be suggested and each aspect shall be considered from the use and esteem value angle.

1. What is the item and what functions does it perform ?
2. Does the design of the product contribute value ? Whether a part or component could be eliminated without reducing its use or its esteem value ?
3. Whether the cost (say, of a part or component) is proportionate to the use value ?
4. Are all the features of the product essential ? Whether some features involving extra operation cost could be eliminated ?
5. Could a part or component be substituted by a cheaper one without impairing its value ?
6. Is it possible to reduce cost of material by,
 - (a) the use of substitute materials which may be cheaper,
 - (b) specification of product to economise usage of materials,
 - (c) reducing the quality of materials,
 - (d) eliminating waste of materials in operation,
 - (e) standardising material,
 - (f) tapping alternative source of supply ?
7. Are all the labour operations necessary or whether alternative cheaper operations are possible ?
8. Whether the existing processes or methods of manufacture could be bettered by standardisation, by alternative processes or methods, by simplification, or by more mechanisation ?
9. Is it possible that a number of products use common standard parts ?

Illustrations of Value Analysis. The relationship between value, function and cost may be expressed as :

$$\text{Value} = \frac{\text{Function}}{\text{Cost}}$$

Value can be improved by (i) improving function, cost remaining constant or (ii) improving function and reducing cost or (iii) reducing cost, function remaining constant. A few illustrations are given below :

Function improved, cost constant :

- (i) Cast iron components, purchased from a sole supplier, were machined into the final product. Cracks often appeared during the machining operation and the rejection on this account was 5%, which was considered to be normal. An alternative source of supply was tapped and the components were obtained from the new suppliers at about the same price as the previous supply but the rejections came down to 2%.

Function improved, cost reduced :

- (ii) Two small parts were rivetted together before assembly in the product, a machine tool. This was not giving satisfactory service as the joint frequently broke off during operation. The two parts were redesigned and machined into one combined unit, thus doing away with the necessity of rivetting. This improved the function of the part and the machining cost was lower than the cost of rivetting.

Function constant, cost reduced :

- (iii) a moulded rubber gasket was manufactured at a cost of Rs. 5 each. As cost of raw material went up, experiments were carried out with plastic material and it was found that plastic gasket could do equally well. The cost was substantially reduced.
- (iv) Products with tight tolerance limits usually involve more wage costs and sometimes need special machines for their manufacture. Costs may be reduced if by adopting alternative processing or improved technology, the tolerance limits are relaxed.
- (v) A metallic wire net was used to shield an electrical equipment. It was found that a perforated metal piece could do as well, at a much lower cost.

Advantages of Value Analysis. The advantages of value analysis may be summarised as follows :

- (i) It is a powerful tool for cost reduction.
- (ii) Since value analysis makes a close study of a product in order to determine the features which would give the highest satisfaction to customers, the manufacture of most suitable products is ensured.
- (iii) The desired quality of products is maintained.
- (iv) Fullest possible use is made of all resources.
- (v) Improved and rationalised methods of production and use of latest techniques raise productivity and minimize cost. At the same time, it helps to keep management abreast of the latest technological and other developments and also broadens their outlook.

- (vi) By a continuing search for improvement, value analysis creates the proper atmosphere for increased efficiency.
- (vii) Value analysis is a specialised job that utilises the talents of a team composed of persons drawn from the various sectors of the business. This has the effect of integrating the various management functions and infusing a spirit of co-operation and raising the morale.
- (viii) Effective use is made of the creative ability and other qualifications of the staff. This creates work interest.

COST REDUCTION

Profit is the resultant of two varying factors, viz. sales and cost. Wider the gap between these two factors, larger is the profit. Thus, profit can be maximised either by increasing sales or by reducing costs. In a competitionless market or in case of monopoly products, it may perhaps be possible to increase price to earn more profits and the need for reducing costs may not be felt. Such conditions cannot, however, exist permanently and when competition comes into play, it may not be possible to increase the sale price without having its adverse effect on the sale volume which, in turn, reduces profit. Besides, increase in price of products has the ultimate effect of pushing up the raw material prices, wages of employees and other expenses all of which tend to increase costs. In the long run, substitute products may come up in the market, resulting in loss of business. Avenues have, therefore, to be explored and methods devised to cut down expenditure and thereby reduce the cost of products. In short, cost reduction would mean maximisation of profits by reducing cost though economies and savings in costs of manufacture, administration, selling and distribution.

Cost reduction may be defined as the real and permanent reduction in the unit costs of goods manufactured or services rendered without impairing their suitability for the use intended. As will be seen from the definition, the reduction in costs should be real and permanent. Reductions due to windfalls, fortuitous receipts, changes in government policy like reduction in taxes or duties, or due to temporary measures taken for tiding over financial difficulties do not strictly come under the purview of cost reduction. At the same time, a programme of cost reduction should in no way affect the quality of the products nor should it lower the standards of performance of the business.

Broadly speaking, reduction in cost per unit of production may be effected in two ways, viz.

- (i) by reducing expenditure, the volume of outturn remaining constant, and
- (ii) by increasing productivity, i.e. by increasing volume of outturn, the level of expenditure remaining unchanged.

Both these aspects of cost reduction are closely linked and they act together—there may be a reduction in the expenditure and at the same time, an increase in productivity.

Cost Reduction and Cost Control. Cost reduction is not cost control. Both cost reduction and cost control are efficient tools of management but their concepts and procedures are widely different. The differences are summarised below :

Cost control

1. Cost control represents *efforts* made towards achieving a target or a goal.
2. The process of cost control is to set up a target, ascertain actual performance and compare it with the target, investigate the variances, and take remedial measures.
3. Cost control assumes existence of standards or norms which are not challenged.
4. Cost control is a preventive function ; costs are optimised before they are incurred.
5. Cost control lacks dynamic approach.

Cost reduction

1. Cost reduction represents the *achievement* in reduction of cost.
2. Cost reduction is not concerned with maintenance of performance according to the standards.
3. Cost reduction assumes the existence of concealed potential savings in the standards or norms which are therefore, subjected to a constant challenge with a view to improvement, by bringing out the savings.
4. Cost reduction is a corrective function. It operates even when an efficient cost control system exists. There is room for reduction in the achieved costs under controlled conditions.
5. Cost reduction is a continuous process of analysis, by various methods, of all the factors affecting costs, efforts, and functions in an organisation. The main stress is upon the 'why' of a thing, and the aim is to have continual economy in costs.

Organisation for Cost Reduction. Cost reduction is a continuous process embracing all the functions and divisions of a business, and it entails criticism of the existing performances at all levels of management. For the successful implementation of a programme of cost reduction, it is essential not only that this criticism be accepted in the right spirit with honesty and grace so that corrective action may be taken, but also that the programme should create sufficient interest and zeal amongst the staff. Any failure or inefficiency brought to light should not be taken in a fault finding, condemning, or vindictive attitude by the upper level management. A right atmosphere should be created for the lower level to come forward boldly with concrete suggestions that may involve admission of mistakes and even self-criticism.

It would thus be seen that cost reduction requires co-operation at all levels and the cost reduction programme should be so organised that a combined action is taken with the common aim of benefit to the business. To motivate the staff, it is

necessary to properly train and educate them. Incentives should be offered for better performance and suitable rewards in the form of increment in salary, promotion, or raise in status should be given for such new ideas put forth by the employees that ultimately result in cost reduction.

The organisation for instituting a cost reduction programme varies with the size of the concern, nature of business, and individual requirements. Usually, there should be a high powered committee for formulation of the cost reduction plan and its operation. Since cost reduction covers a wide field and employs diverse techniques, it requires for its proper implementation, the services of experts from all the sectors of the business. Responsible executives of various functions such as purchase, planning and design, production, sales, distribution, finance, and research should, therefore, be represented in the *cost reduction committee*. The committee should plan the programme, motivate it by setting up a simple organisation for its implementation, and allot assignments to the executives responsible. The committee should also fix priorities amongst the various cost reduction plans, and review the actual performance from time to time.

Smaller organisations may not afford to have full time staff for cost reduction. Either their cost accountants have to devote some time to cost reduction programme, or the assistance of outside consultants may be obtained to deal with specific problems.

Cost Reduction Programme. Cost reduction aims at improvement of human efforts. In a business organisation, several persons are engaged in diverse activities. This opens up a wide field for cost reduction and more the complexity of efforts in an organisation, larger is the scope for cost reduction. There should, therefore, be a well built programme which should aim at integrated cost reduction : it should be an organised continuous activity to cover all the important functions of the business. The fields to be covered in a cost reduction programme are discussed later.

The cost reduction programme may be a short-term or a long-term scheme. When special problems such as reduction in profit, specific inefficiencies in certain spots, or fall in production or sales likely to adversely affect the financial and economic positions of the business are being considered, immediate action is called for. A special short-term cost reduction programme is geared into action to meet the situation and improve the position. Long-term cost reduction plans involve major reductions in costs and may involve capital expenditure. While in the short-term, the extent of the cost reduction programme will be limited to a minimum programme to tide over the current difficulties, suitable targets should be set in the long-term, in the form of, say, expected profit or expected return on capital employed, and attempts made to achieve the target through the cost reduction programme.

Briefly, a programme of cost reduction consists of the following :

- (i) Numerous centres or points where costs are incurred are located and grouped according to departmental responsibility.
- (ii) Each such point or group of points is then subjected to a value analysis scheme to determine whether optimum efficiency has been achieved in its performance, or whether there is room for cost reduction.
- (iii) Suitable techniques are thereafter applied to reduce costs.

No cost reduction programme can be effective unless there is a joint effort made by all the departments concerned and the plan is linked with responsibility management. Allocation of responsibility to the various levels of management is an important requirement of cost reduction. Just as an executive is responsible for control of the costs incurred by him, he should also be made responsible for cost reduction of the operations and spheres under his control. The programme for cost reduction should be clearly defined and responsibility delegated, so that each executive is aware of his role in the overall scheme of cost reduction and of the function he has to perform.

Requisites of a Satisfactory Cost Reduction Scheme. The following aspects should be considered in the launching of a cost reduction scheme and its satisfactory implementation : —

- (i) A suitable programme for cost reduction should be laid down.
- (ii) There should be a proper organisation for the execution of the scheme.
- (iii) The top management should be aware of the benefits of the scheme and should be fully convinced about its necessity.
- (iv) There should be an efficient system of reporting and communication between the accountant and the top management.
- (v) As cost reduction is a continuous process, sustained interest of the management should be maintained. The scheme should not be allowed to degenerate into a stereo-typed routine.
- (vi) Except for temporary cost schemes which serve as mere palliatives meant to sort out short-term difficulties, the cost reduction scheme should cover all aspects and spheres of management.
- (vii) A close survey of the current and past operations should be made to determine priorities to be accorded to the various aspects.
- (viii) There should be a system of operation and procedure research.
- (ix) There should be close co-operation amongst the personnel connected with the scheme. Each departmental executive should be given a list of the points where he is expected to seek economies and at the same time, he should be encouraged to put forth his own suggestions for improvement.
- (x) There should be a procedure for regular follow-up of the plan. This would also entail the evaluation of the cost reduction performance. Targets for cost reduction may be set and the actual cost reduction achieved compared with the targets.
- (xi) The cost reduction plan should not be confined to reducing the level of expenditure, but should question the necessity for an item of expenditure and eliminate uneconomic and unnecessary activities.

Fields Covered by Cost Reduction. The critical areas of application of cost reduction methods and the lines of approach in laying out a cost reduction plan are suggested as follows : —

(a) *Product design* : Cost reduction starts with the design of the product. Product design being the first step in the manufacture of a product, the impact of any economies or cost reduction effected at this stage will be felt throughout the

manufacturing life of the product in all fields, viz. production, sales etc. Design, therefore, constitutes the most important field where cost reduction may be attempted. Possibilities of cost reduction should be investigated, both when introducing new designs and when seeking improvements of the existing designs. It is worth while putting in some more care and a little more money at the initial stage than to incur losses and wastage later when production is established. Introduction of value analysis method at the designing stage would go a long way in achieving successful results. The aim is to obtain maximum benefit or use value for the product at the minimum cost, without affecting its sales appeal or esteem value. Efficient designing for a new product or improving the design for an existing product, reduces cost in the following manner :

(i) *Material cost* Cheaper substitute, higher yield and less quantity and varieties of materials, so that storage cost and investment on inventory are reduced

(ii) *Labour cost* Minimum tolerance, reduced time of operation, and increased productivity

(iii) Cost of jigs, tools, and fixture are minimised

(iv) Standardisation and simplification in variety increases productivity and reduces cost because of introduction of mechanisation, longer run, less capital, employment, simplified inspection, etc.

(v) If final shape, weight and compactness of the product are properly designed, packing and transportation costs are reduced

(vi) Increase of esteem value e.g. better appearance, quality, functional efficiency, wide application, and increased life

(vii) Prompt designing reduces the loss on unsold products in case of seasonal products

(viii) Reduction in after sales service costs.

(b) *Organisation* It is not possible to measure the cost reduction resulting from an improvement in the organisation. Nevertheless economies are bound to be achieved if the following considerations are looked into :—

(i) Definition of each function and responsibility

(ii) Proper assignment of tasks and delegation of responsibility, overlapping is avoided

(iii) A suitable channel of communication between various management levels

(iv) Co-operation and close relationship between the various executives

(v) Removal of doubts and points of friction

(vi) Encouragement to employees for cost reduction suggestion

(c) *Factory layout and equipment* : Factory layout and equipment influence costs to a large extent. A cost reduction programme should study the factory layout and the utilization of the existing equipment to determine whether there is any scope for cost reduction by elimination of wastage of men and materials and maximum utilization of the facilities available. The necessity for replacement of plants, introduction of new techniques, or expansion of facilities should be considered, and various alternatives explored with a view to reduction of cost. The economics of manual labour production vis-a-vis machine production methods is another field for cost reduction study. With automation and expensive specialised machine tools, machine installation and running costs assume greater importance, which call for utilization of the machines to the fullest extent. Any concealed bottlenecks and difficulties standing in the way of maximum utilization of plants and other facilities should be probed into. For instance, there is no point in detailing a skilled worker to manage a number of semi-automatic machines, all at a time, if he is not able to fully utilize all the machines, although in the process, he is

able to occupy himself fully. It should be rather the other way round ; if all the machines are fully utilized, the worker should automatically be fully occupied.

(d) *Production plan, programme, and methods* : Production control ensures proper planning of work by installing an efficient procedure and programme of materials ordering, correct machine loading, and proper utilization of material, manpower and resources, so that there is no waste of time and money due to waits for components, men, materials, etc. An efficient cost reduction programme should examine the following points relating to production control :—

- (1) Whether wastage of manpower and material is kept to the minimum.
- (2) Whether there is any scope for reducing idle capacity.
- (3) Whether the procedures for the control of stores (purchases, inspection, and storage) and maintenance services are efficient.
- (4) Whether labour wastage may be reduced and productivity increased by eliminating faulty production methods, plant layout, and designs, or by introducing incentive schemes.
- (5) Whether the best method of production has been adopted and whether it is possible to incorporate new improved methods or ideas in order to reduce cost.
- (6) Whether production schedule can be improved to match delivery schedules.
- (7) Whether more improved tools and modernised equipments can be used in order to minimize usage, maximize yield and so, reduce cost.
- (8) Whether there is scope of reduction in indirect material and labour costs by introducing adequate control systems for such costs.
- (9) Whether there is any scope of reduction in overhead costs ; whether a budgetary system is in operation to ensure control over overhead cost.

(e) *Administration* : The points to be examined in this area will be :

- (i) The extent of use of job evaluation as a basis for reducing staff.
- (ii) Systematic supervision of the use of office machinery.
- (iii) Possibility of reduction of files and filing space.
- (iv) Systematic and smooth flow of work.
- (v) Expenditure on printing postage and telephone.
- (vi) Internal information system and flow of reports.
- (vii) Use of forms and stationery.

(f) *Selling and distribution* : The major points that need examination with a view to cost reduction in this area are :

- (1) Whether channels of distribution are efficient and economical.
- (2) Whether distribution and selling methods ensure promptness.
- (3) Whether there is an effective system of sales promotion.
- (4) Whether market research is adequate (customers pattern should be reviewed).
- (5) Whether market methods, both for home and export trades, are satisfactory.
- (6) Whether there is any possibility of reduction in selling and distribution expenses without impairing the efficiency of the sales division.

(g) *Personnel management* : The cost reduction programme should explore the following :—

- (i) Reduction in labour content of products by suitable work study techniques ; introduction of sound incentive schemes.
- (ii) Improving machine loading and reduction in batch frequency.
- (iii) Eliminating faulty product design, factory layout, and production methods.
- (iv) Reduction in labour costs by improving labour relations and morale of workers by the introduction of incentive payments, welfare measures, and better working conditions.
- (v) Reduction in labour time by simplification of work.
- (vi) Introduction of training schemes and facilities.

(h) *Purchase and materials control* : Some of the aspects that may be looked into are :

- (i) Effective and economical purchase of materials.
- (ii) Delivery of materials on scheduled dates.
- (iii) Adherence of economic ordering quantities.
- (iv) Purchase at competitive prices.
- (v) Keeping low inventory ; less investment in stock.
- (vi) Effective check on goods received.
- (vii) Control over material storage and issues.
- (viii) Economy in the cost of materials handling.
- (ix) Control and reduction of materials utilization.
- (x) Check up of materials yield.

(i) *Miscellaneous services* : Consideration of cost reduction methods may be extended to the following :—

- (1) Economic supply and efficient utilisation of power, fuel, and water services.
- (ii) Proper system of preventive and curative maintenance.
- (iii) Control of quality of products ; minimum cost of inspection.
- (iv) Control over expenditure and the activities of the offices and clerical services in the purchase, sales, secretarial, accounting and other departments.

(j) *Financial management* : This is another important field for effecting cost reduction. The points to be examined are :

- (i) Whether there is any scope for improvement in the system of control over utilization of finances, fixed capital investment and working capital.
- (ii) Whether capital is economically employed so as to give the maximum return.
- (iii) Whether there is any over-investment.
- (iv) Whether capital is secured at economical cost.

Tools and Techniques for Cost Reduction. The various techniques used for achieving cost reduction are practically the same that have been suggested for the purpose of cost control and efficient management. Some of these are :

- (i) Budgetary control and standard costing.
- (ii) Work study and organisation and method procedure.
- (iii) Value analysis : In fact, cost reduction forms a part of a value analysis scheme. Value analysis goes further than cost reduction ; while cost reduction examines costs with a view to reducing it, value analysis examines the functions which are required to be provided and then establishes the method of achieving these functions at the lowest cost.

(iv) *Standardisation* : Standardisation plays an important part in cost reduction.

The following benefits of standardisation may be noted :

- 1. Reduction in capital investment, say, by elimination of unnecessary stock.
- 2. Reduction in prices due to larger batch quantities.
- 3. Reduction in costs of designing, tooling, store keeping and inspection.
- 4. Reliability of product.
- 5. Improvement in quality.

(v) *Simplification and variety reduction* : Diversification means entry into new product lines, processes, services, or market. Diversification may be either horizontal or vertical. Though diversification in a business is sometimes necessary

for growth, stability, and flexibility and to earn more profits, too wide a diversity of components and products impairs the manufacturing efficiency and increases costs. Reduction in variety results in less costs due to the following factors :—

1. Longer runs.
2. Reduction in tool setting costs.
3. Higher productivity leading to reduced costs and increased sales.
4. Concentration on administration, sales, advertising and distribution for fewer products.
5. Large staff to look after the different products is not required.
6. More mechanisation and use of special purpose plants.
7. Concealed losses on non-profitable products eating up the profits on the efficiently manufactured products are avoided.
8. Easier maintenance of plants and services.
9. Reduced inventory of raw materials, components and finished goods.
10. Reduction in cost of inspection.
11. Avoidance of idleness of plant and tools.
12. Improved service for the customers.

(vi) **Economic batch quantity** : The theorem on economic batch quantity was discussed in Chapter 7. When the use of alternative plants and machinery is under consideration, the economics of batch quantity should not be lost sight of. It may be stressed that the batch quantity or batch frequency is sometimes dictated by the specific design of the plant used.

(vii) **Quality control** : Quality control ensures through a system of testing and inspection that the product comes up to the required standard and specification as regards quality. The objectives of quality control are to place quality products in the hands of the customers according to their preferences, to provide a control over the performance efficiency of a manufacturing operation or process, and to prevent and eliminate waste. Less rejection results in low cost and consequently low price.

It is the manufacturing efficiency and not inspection which produces quality products. Inspection is, therefore, not control in itself, but is only a tool of quality control that highlights work which is sub-standard or less efficient, so that corrective action can be taken to improve it.

Cost reduction may be effected through an efficient system of quality control. Though a cent per cent inspection of products is not always necessary, it is advantageous to have stagewise or operationwise inspection. Detection of sub-standard work in the earlier stages of manufacture, saves further costs on subsequent operations. Care should also be taken in fixing suitable tolerance limits within which the inspection has to operate. Too rigid an inspection costs money as too many products would be scrapped but at the same time, too liberal an inspection will result in defective work being passed off as good production.

- (viii) Improvement in design.
- (ix) Substitute material utilization.
- (x) Automation.
- (xi) Operations research.
- (xii) Coding and classification.
- (xiii) Production planning and control.
- (xiv) Inventory control.
- (xv) Job evaluation and merit rating.
- (xvi) Training schemes.

- (xvii) Business forecast.
- (xviii) Market research.

PRODUCTIVITY

In a business, divers resources like raw materials and components, labour, capital, plant and machinery, buildings, repair and service facilities, organisation, and management are employed. Each of these resources that we may call input, governs production and helps to achieve the final result. In the case of a manufacturing business, the final result or output is the end product. Productivity represents the relationship that exists between the output and the input. Productivity aims at the maximization of output by planned and most economic use of input and elimination or minimization of waste. The operational and executive actions of the management have the effect of adding value to the input and making it to grow into output. Productivity is thus a measure of the growth or added value ; it is a measure of the effectiveness of the resources applied for production. A high added value would indicate high productivity.

Evolved as an economic concept, productivity is utilised for scientific management. Productivity should not be confused with production ; increase in production does not necessarily mean increase in productivity. If, for instance, an increase in production is effected by a corresponding increase in the quantum of input, there is no increase in productivity. On the contrary, productivity may decrease if the increase in input is proportionately more than the increase in output. Let us assume an example. A factory working one shift employs 100 workers and has a daily output of 200 articles. 100 more men are recruited to run a second shift and production increases from 200 articles to 400 articles per day. This is a case of increase in production but not in productivity ; by doubling the efforts, the output has simply been doubled and nothing more.

Productivity, in its simple form, may be expressed as one of the following ratios :

Output/Input	Growth/Capital employed
Gross income/Gross expenditure	Cost plus added value/Cost

In other words, productivity is the amount of output per unit of input. If by less utilisation of resources more output can be obtained, there is an increase in productivity. As the input consists of a number of production factors and elements, productivity can also be determined separately for each of these factors such as labour, material, or plant utilization. Both the output and the input may be expressed in terms of physical units or in terms of money. As we will see later, the heterogeneous nature of the physical units available for measuring various inputs makes determination of the ratio difficult and complicated. Cost is, therefore, a better measure of productivity but then again, the use of monetary terms has its limitation. (These limitations have been discussed later).

We can measure international productivity, or the productivity of a nation, an industry, or a factory, or even a department. Since the economic and social conditions and price levels are widely different in various countries, measurement

of *international productivity* is subject to severe limitations. *National productivity* is measured as the ratio of gross national product to total input, where the gross national product is the total production or services rendered in the country as a whole, and the total input is the efforts made and resources put in to obtain the gross national product — both expressed in terms of money. Though providing a means of measuring the national growth, national productivity is not effective as a means of measuring efficiency as it does not furnish data for inter-firm comparison within an industry. The latter purpose can only be achieved by measuring the productivity of the particular industry or the business.

Measurement of Output. Of the two figures, viz. output and input required in the computation of productivity ratio, output is sometimes difficult to measure. As the output consists usually of a process, a product, or a group of products, it may be measured in terms of sales value or quantity, or both. Monetary sales value is, however, not a true measure of output because due to the varying profit margins and marketing costs, it fluctuates from period to period and hence, is not comparable. Quantitative data (volume or number of units) are better measures of output but where varieties of products are manufactured and the product mix and the types, specifications, and qualities of the products are liable to change from time to time, the data are rendered uncomparable. The problem which arises due to complicated product mix may be simplified if the output of each product is measured separately and individual productivity index is calculated for each of them. This is possible only if the input can also be measured separately for each product. The commonly adopted method is to take both sales value and quantity into account for measuring output. The units for output are weighted by a standard selling price selected for the base period. (The base period data is the norm with which performances of future periods are compared.)

Measurement of Input. Since the input is comprised of a number of diverse factors, it is not possible to have a common physical unit for measurement of all these factors. Each of the input factors is, therefore, measured in terms of different yardsticks of measurements, as shown below :

<i>Factor</i>	<i>Unit of measurement</i>
Labour	Man-hour, man-day, man-shift, man-year, money value
Material	Physical unit of quantity, weight, volume, money value
Shop expenses	Machine hour, labour hour, money value
Power services	Kilowatt hour
Maintenance and repairs	Man-hour, man-day
Plant and machinery	Money value, capacity, usage

In order that productivity ratios may be comparable, one suitable unit should be selected for measuring an input factor and the same unit should be consistently used every time the ratio is worked out.

Difficulty arises when comparison is made between different units in an industry or between different departments in the same factory. This is because of the diversity in defining an input factor. For a true comparison, it is essential to standardise the various terms in use.

Determination of Factoral Productivity and Overall Productivity. *Factoral productivity*, i.e. the productivity of individual factors can be determined provided two conditions are satisfied, viz. that both the input and output are expressed in

terms of suitable units, and that it is possible to correlate each input factor with specific output. *Overall productivity*, i.e. the productivity of the business as a whole, taking all the input factors together, may be determined provided the different inputs are expressed in the same quantitative unit. To obviate the difficulty arising out of the diversity of methods of measurement of units of input, an alternative method is to adopt cost as a convenient measure of productivity. Cost is taken to represent all the physical efforts of the input factors. The method is to convert various input factors and the output in monetary terms. The ratio between the output and the total inputs, expressed in terms of money, is the measure of overall productivity.

$$\text{Overall Productivity} = \frac{\text{Cost of output}}{\text{Cost of total input}}$$

Another method for measuring overall productivity is to adopt labour productivity (which is considered to be the most important factor in productivity computations) as a base and express the productivity of the other elements in equivalent terms of labour productivity. The conversion of the various factors in terms of labour may be done in two ways, viz. by establishing a relationship between the costs of the factors, and on the basis of replacement factor. Under the first method, if the cost of materials in a year be Rs. 3 lakhs and the cost of wages be Rs. 2 lakhs, a rupee of material will be taken as equivalent to Re. 2/3 of labour. In the second method, if 18 workers can replace a plant, the latter will be equivalent to eighteen times the labour input

Labour productivity may be measured in several ways, a few of which are given below :

(i) *Output per man-hour*. Where the output is uniform with regard to quality and design, productivity may be determined in terms of output per man-hour.

$$\text{Labour Productivity} = \frac{\text{Total output}}{\text{Total man-hours}}$$

The output may be expressed either in physical units or in terms of money. If more than one type of product are manufactured, the output of the various types should be properly weighted.

The productivity report in Fig. 18.1 illustrates this method.

PRODUCTIVITY REPORT			
Period :	Department :		
	Actual	Budget	Actual last period
Output units (a)			
Working hours (b)			
Number of workers (c)			
Total man-hours (d = b × c)			
Labour productivity per man-hour (a ÷ d)			

Fig. 18.1. Labour Productivity Report

(ii) *Labour hours per unit of production.* This index is the reciprocal of the output per man-hour.

$$\text{Productivity} = \frac{\text{Total labour hours}}{\text{Total output}}$$

An advantage of this method over the previous one is that if different types of output can be expressed in some common unit, e.g. weight, it is easy to measure overall productivity, which will simply be the aggregate of the productivity of individual products or processes.

(iii) *Actual time compared with standard time.* Where it is possible to set standard time by work measurement or time study methods, comparison of the actual time with standard time provides a suitable index for labour productivity. The method of determining the work content of a job in terms of standard hours was discussed in Chapter 3. The actual output of work expressed in standard hours represents the productivity ratio. Productivity of machines may also be measured by this method.

(iv) *Added value per unit of labour cost* Added value for a product is taken as the difference between its sale value and the material cost.

$$\begin{aligned} \text{Labour Productivity} &= \text{Added value for the product} / \text{Total wages cost} \\ &\text{or} \\ &= \text{Sales value minus material cost} / \text{Total wages cost} \\ &\text{or} \\ &= \text{Wages plus overhead plus profit} / \text{Wages} \end{aligned}$$

Though a very useful index for comparison of labour productivity, the added value ratio suffers from the limitations mentioned below :

- (a) Change in price level complicates the index measurement.
- (b) Being dependent upon supply and demand, sales value is not related to the efficiency of labour.
- (c) Difficulty in defining labour, e.g. whether or not to include the salaries of supervisors and office staff with the wages of workers, in determining the labour cost.
- (d) High productivity may be nullified by increased cost of mechanisation of labour. This difficulty arises in all cases where factoral productivity is measured.

Determination of overall factoral productivity presents the following further difficulties :

(i) There is always a time lag between the input and output. Adoption of cost as a measure of input and output vitiates the measurement of productivity if during this time lag, there has been a change in the price level ; the input and output are then subjected to varying cost conditions. This can, however, be remedied by converting the input and output to standard price levels.

(ii) Use of cost in measuring productivity leads to inaccurate results because of another factor, viz. that the impact of economic conditions may not be uniform on all the input factors. For instance, there may be an increase in the labour input because of, say, a general rise in wages but all the other input factors may remain unaffected.

(iii) **Inter-dependence of factorial productivities.** The individual productivity of labour, material and machines are inter-dependent processes as each input factor has an effect on the rest. For example, labour productivity may be influenced by factors like quality of materials, working conditions provided, and condition of plant and machinery ; material productivity may be affected by labour and machine efficiency, and so forth. Mechanisation may increase labour productivity but this may be of no use if there is an increase in the machine expresses. The factorial inter-dependence may be expressed by a large number of simultaneous equations with different variables or unknowns. The overall productivity may be computed by solving these equations.

(iv) Sometimes the inter-dependence of the various factorial productivities is not certain and cannot, therefore, be expressed mathematically ; the relationship is more subjective than mathematical.

Improving Productivity. The methods of increasing productivity are practically the same as those of scientific management. Almost all the techniques of planning and control available to the management such as production planning, production control, inventory control, operations research, cost control, budgetary control, market research, preventive maintenance, management organisation, inter-firm comparison, and organisation and method aim at and help towards increasing productivity.

The main condition for increasing productivity is to improve the performance of each element of input. The various aspects to which attention should be paid in particular, for increasing productivity, are discussed below :

(1) *Organisation and production control.* This should cover the following aspects :—

- (a) Examination of the general organisation of the concern so as to fix lines of responsibility.
- (b) Simplification, standardisation, and specialisation in production lines.
- (c) Application of work study techniques.
- (d) Elimination of time on non-productive work.
- (e) Introduction of a system of production control.
- (f) Integration of the functions of the various departments.
- (g) A proper system of quality control—elimination of defective production
- (h) An efficient system of budgeting, costing, cost control, and cost reporting.

(2) *Design.* High productivity depends upon the correct designing of the product. The design should be such as to enable the production of optimum quality at a minimum cost. The same principle applies in the case of construction projects. Faulty designing leads to waste, bottlenecks, increase in cost, and low productivity.

(3) *Plant and machinery, land and buildings.* For high productivity, the optimum nature and size of plant and machinery should be determined. Lack of suitable plant and machinery results in wastage, delay, and more cost, but at the same time, installation of large and heavy plant and machinery, not required for immediate needs, would mean locking up valuable capital and increase in cost. The economics of work by manual labour versus mechanical devices should also be considered. With regard to land and building, wastage of space and non utilization, less utilization or mis-utilization of buildings should be avoided.

(4) *Labour efficiency.* As we have seen earlier, labour is the most important factor affecting productivity. A few of the factors which may be looked into with a view to improving labour productivity are :

- (i) Recruitment of the right type of men and avoidance of labour shortage.
- (ii) Training of workers.
- (iii) Work study, fixation of rates, and incentive schemes.
- (iv) Production planning to ensure steady flow of raw materials proper machines maintained in good condition and better working conditions.
- (v) Simplification and standardisation of work.
- (vi) Utilisation of suitable workers of the right type of skill.
- (vii) Elimination of man power wastage—avoidance of idle time.

(5) *Material performance.* Material productivity may be increased by :

- (i) Suitable designing whereby usage of material is minimized.
- (ii) Specifying the quantity of material required for the manufacture of specified units of a product (as in bill of materials) prevents excess use of materials.
- (iii) Purchase of correct materials at the correct time.
- (iv) Improving quality of materials.
- (v) Removing machine faults.
- (vi) Employing workers of requisite skill so that defective work, scrap and wastage are reduced.
- (vii) Efficient handling of materials.

(6) *Machine performance.* The productivity of a machine may be measured by comparing the utilised capacity against the rated capacity less unavoidable interruptions. Machine productivity may also be expressed as,

Total production of the machine expressed in a suitable physical unit ;
Total machine hours.

Machine productivity may be increased by :—

- (i) Optimum utilisation of machine time ; elimination of machine time wastage and avoidance of idle time.
- (ii) Proper system of maintenance, which should include preventive maintenance.
- (iii) Efficient production planning, scheduling, and work loading to avoid bottlenecks and idle time of machines.
- (iv) Employment of skilled and efficient operatives.
- (v) Proper maintenance of machine tools.

(7) *Marketing.* Marketing productivity may be represented by :

Sales or net profit for specific segment

Marketing cost (or total marketing effort for the segment)

Marketing productivity may be improved by :

- (i) increasing sales or net profit with the same or less amount of marketing effort, or
- (ii) effecting cost reduction in marketing costs.

Advantages of Higher Productivity. Higher productivity has the effect of generating prosperity for the business, the industry, the worker, the consumer, and the nation, as a whole. The following factors contribute to the prosperity :—

- (1) Reduction in cost and price.
- (2) Increased sales and more profit.
- (3) Expansion and growth of industry.
- (4) Expansion of market.
- (5) Better working conditions for the workers, and possible reduction in working hours.
- (6) Increased capacity for payment of high wages and suitable incentives.
- (7) Improved morale of workers and staff.
- (8) Full value, better quality, and low price for the consumer.
- (9) Increase of national wealth.
- (10) Increase of per capita income.

(11) Improved standard of living for the people.

Productivity and the Cost Accountant. We had earlier discussed the importance of costs in the measurement of productivity. Cost is the common denominator for expressing input and output and for computing the productivity indices. We also know that low cost is associated with higher productivity, provided the other factors remain unchanged. High productivity requires concerted action on the part of the various sectors of business such as purchase, marketing, production, finance, and research and development and it is the cost accountant who acts as the co-ordinating link. The cost accountant, therefore, plays a very prominent role in the measurement and improvement of productivity. He renders assistance in the following manner :--

- (1) Interpreting in terms of cost (i.e. material, labour, and overhead), the various techniques applied by the management to increase productivity.
- (2) Helping management to deal with decision making problems.
- (3) Assisting the introduction of a system of budgetary control and standard cost and evaluating performance in terms of unit costs. The deviations from budgets or standards are highlighted, so that corrective action may be taken and future planning done effectively.
- (4) Introducing cost reduction schemes so as to reduce cost and increase efficiency and productivity.
- (5) Establishing suitable norms or standards of productivity indices with which actual productivity may be compared.
- (6) Evaluating performance of resources like men, machines, materials, and equipments and pointing out idle capacity and waste of resources.
- (7) Control and improvement on cost of labour, materials, and expenses.
- (8) Providing free exchange of information with an improved system of communication and reporting. Significant ratios and indices may be prepared. Reporting should be on the principles of exception.

MANAGEMENT BY OBJECTIVES

Management by objectives is the managerial operational process of setting agreed targets within an organisation or a part of it, for achieving them to provide motivation to various levels of management. Management by objectives is a result-oriented process which makes effective utilization of the resources of the organisation. Factors inhibiting the attainment of objectives are identified for taking action to overcome them. Results are periodically assessed and new targets set, where necessary. In all these processes, there is a complete integration of the individuals with the organisation and of the organisation with the environments, internal as well as external.

The process of management by objectives may be divided into the following four basic steps :

- (1) Identifying the objectives :
- (2) Setting the objectives ;
- (3) Establishing the plan and improving management performance ; and
- (4) Performance review.

1. *Identifying the objectives* : The key or central objective of a concern is to maximise the long-term return on the resources employed. A concern has various other specific objectives—long-term and short-term, financial and non-financial—some very important and implicit in the conduct of the business and some obscure and secondary and not easily identifiable.

The objectives of a concern relate to a very wide range, some of which are :

- (a) Profitability, e.g. to improve the return on capital employed.
- (b) Market, e.g. increase in share of market and sales volume, improvement in quality, market effectiveness and price.
- (c) Production and productivity, e.g. improvement of production targets, productivity of men and machines, etc.
- (d) Managerial performance, e.g. targets for selection, training, salary structure, methods of rewarding, etc.
- (e) Workers' performance, e.g. improvement of worker motivation and worker participation.
- (f) Resources, financial and physical, e.g. objectives for obtaining, conserving and effectively utilizing the resources.
- (g) Research and development, e.g. innovating the products, processes and services, improving market and pricing strategies, etc.

The objectives or targets are established after a thorough study and evaluation of, (i) the weakness and strength of the concern, (ii) the influence of external environmental factors, (iii) alternative courses of action to implement the objectives, and (iv) their impact on the other areas and objectives of the concern.

2. *Setting the objectives* : Having defined the company's long-term and short-term objectives, the next step is to fix priorities amongst the various objectives. It may not be possible to set the objectives all at a time and a right balance is to be found between the long-term and the short-term objectives and between the equally important but conflicting objectives. This is a difficult managerial problem, particularly when the resources are limited or scarce and correct planning has to be made looking to the overall position of the concern. Short-term objectives, the achievement of which would bring in immediate results, often get priority but these should be regarded as mere stepping stones leading to the path towards long-term objectives.

3. *Setting the plan and improving management performance* : The next step is the setting of the Strategic Plan, incorporating the established objectives, which seeks to optimise profit through the best allocation of resources wherever they are required. The Strategic Plan is further broken down into the detailed Tactical plan for implementation at the various managerial levels. Each manager not only knows what exactly he is expected to do but he is also told about (i) the performance targets or standards set and the results expected from him in line with the various objectives established, and (ii) the agreed performance plan for achieving the objective. The plan is time-bound and the manager is allowed maximum flexibility and freedom to operate it. Conditions are created in which it is possible to achieve the results expected.

4. *Performance review* : A suitable management information system should be introduced which would ensure a proper review for measuring and discussing progress for achieving the results or the objectives set.

Some of the *advantages or benefits* which may be derived from the technique of management by objectives are :

- (a) A planned and systematic approach to profit growth.
- (b) Motivation and complete involvement of all managerial levels to achieve the set results.
- (c) Suitable balance between the long-term and short-term objectives.
- (d) Prediction of change in environment and its effect on the business.
- (e) Maximum utilization of resources of men, materials, machines and finances, and cutting down their wasteful use.

LEARNING CURVE CONCEPT

A mention of the use of learning curve for pricing was made in the previous chapter. We know that when a specific task or operation is performed repeatedly, the time required to perform the repeat task is in many cases, less than the time taken to perform it originally. The concept of learning curve (also known as learning ratio and first developed in 1936) arises out of this phenomenon. The concept states that every time the cumulative production quantity or volume doubles, the cumulative average time per unit (and so the average unit cost) will decline by a given percentage. The effect is that the latest unit produced will cost in time or rupees, a given percentage less than that for the last unit produced prior to doubling the quantity. For example, assuming a cost reduction rate of 20%, which is equivalent to an 80% (i.e. $100 - \text{percentage of reduction}$) learning rate, and 8 hours as the time taken for the first unit, the average time per unit for 2 units will be $(0.8) \times 8 = 6.40$ hours, i.e. a total of 12.80 hours for both. Thus the second unit takes 4.80 ($12.80 - 8$) hours to produce and the incremental cost improvement is $4.80/8 = 60\%$. Similarly the average for 4 units will be $(.8) \times 6.40 = 5.12$ hours each or a total of 20.48 hours. Thus the third and fourth units will take together, $20.48 - 12.80 = 7.68$ hours, and so on for 8, 16, 32, etc. units, as will be seen in the table given below :

Lot or Batch No.	Cumulative production (units)	Average cumulative hours required per unit (on 80% learning rate basis)	Cumulative total hours to perform task
1	2	3	4
1	1	8.00	8.00
2	2	6.40	12.80
3	4	5.12	20.48
4	8	4.10	32.80
5	16	3.28	52.48
6	32	2.62	83.84
7	64	2.10	134.40

When plotted on a graph, the learning curve forms a hyperbola, as shown in Fig. 18.2. It may be noted that the learning curve is called a curve because the

relationship between cumulative production volume and the unit cost is curvilinear.

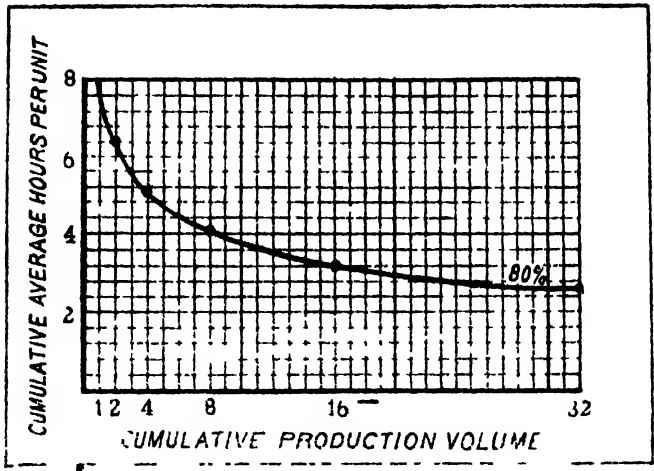


Fig 18.2 Learning curve (on an ordinary graph)

The cumulative average time when plotted on a log-log scale is a straight line, as shown in Fig. 18.3.

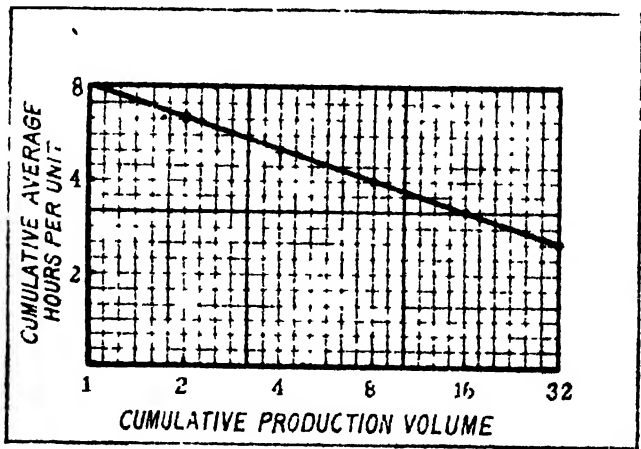


Fig. 18.3. Learning curve (on a log graph)

Expressed mathematically, the formula for learning curve effect is,

$$Y = aX^b \text{ or } \log Y = \log a + b \log X$$

- Where,
- Y = average number of labour hours required for X units,
 - a = number of labour hours required for the first unit,
 - X = cumulative number of units produced, and
 - b = learning index or learning curve constant. This is equal to $\log 1/\log 2$, where 1 is the learning rate. (For earning rate of 80%, $b = \log 0.8/\log 2 = (-) 0.3219$.)

If data are available, the formula stated above may be used to determine the learning rate or given the learning rate and other data required to fit with the formula, values of the variables, Y, X, or a, may be calculated. For example, if a pair of the values of Y and X is given, the number of hours required for the first unit (or batch) and the learning rate can be determined. Assuming the values of Y and X for batches 4 and 5 in the table, we have :

$$\log 4.10 = \log a + b \log 8 \quad \dots (i)$$

$$\log 3.28 = \log a + b \log 16 \quad \dots (ii)$$

Solving equations, (i) and (ii) for log a and b, we get :

$$\log a = 0.9035, \text{ or } a = 8.00 \text{ (This agrees with the figure in the table), and}$$

$$b = (-) 0.3219, \text{ or Learning rate } 0.8$$

To take another illustration ; given the learning rate and the number of hours per unit for the first batch, the average cumulative hours required per unit for a subsequent batch, (say, batch 6), may be calculated as follows :—

$$Y = aX^b = 8 \times 32^{-0.3219}$$

$$\text{or } \log Y = \log 8 + (-.3219) \log 32$$

$$\text{or } Y = 2.62 \text{ hours}$$

The process of learning cannot go on indefinitely but has to end when a certain efficiency level is reached at a given production volume. In practice, to begin with in the first stage, there is a progressive increase in production rate till the maximum expected rate is reached. In the second stage, the maximum rate is maintained and in the third stage, which may be called the reverse learning, the production rate starts falling.

The learning percentage usually varies between 100 and 50, but the 80% curve has been used over years in several industries. A percentage of 100 for learning would mean that there is no learning at all since the subsequent units will take the same time for production as the first original unit. On the other extreme, 50% is the upper limit which can never be reached as will be seen from the illustration given below :

If the average per unit for the first lot = 8 hours,

average per unit for the second lot = $6.5 \times 8 = 4$ hours, and

cumulative hours = 8 hours

This would mean that the second unit will take zero hour for completion, which is impossible.

Application of Learning Curve. Learning curve may be applied to direct labour, materials and spoilage and defective work.

(i) **Direct labour :** Direct labour is the general application area of the learning curve since it is only people who are capable of learning. Learning presupposes a certain degree of inexperience in the performance of an activity and as such, the learning curve is mainly applicable to new activities and new labour force, whether employed on new or old activities. Learning may also be applicable to old activities and old workforce if there has been interruption in the activities concerned for quite some time. An industry that has a high labour turnover rate or where products and processes are subject to frequent changes, is a proper field for the application of learning curve.

(ii) **Materials :** Materials respond to learning only in an indirect way under specific circumstances. The learning curve is applicable mainly to sub-contract or fabrication order placed outside or components purchased from

suppliers. The cost of the sub-contract or the components purchased would normally contain an element of labour and the purchaser will expect that at least a part of the benefit of learning should be passed on to him in the form of reduced price for the repeat orders for the sub-contract or components.

(iii) *Spoilage and defective work* : This is also an area for learning because with the acquirement of more skill and efficiency, losses on account of spoilage and defective production would decline.

On the other hand, the concept of learning curve may not be gainfully applicable in the following cases :—

- (i) Where machine work predominates and the operation time is limited by the speed and feed of the machine.
- (ii) In old established industries where no substantial change takes place.
- (iii) In industries which do not received repeat orders.
- (iv) In small units where the quantity of production is small and costs are low.

Uses of the Learning Curve. The learning curve theory has gained significant importance as a technique for cost prediction and cost control. Some of the uses to which the learning rate may be put to are as follows :—

(i) *Developing bid prices for contracts* : The cumulative average unit cost for the units on order for a contract is used after the application of the learning rate, as the basis for the price to be quoted for the contract. Given the data on Page 891 the bid price for 16 units will for instance, be on 3.28 hours per unit basis and not on 8 hours per unit which is the time for producing the first unit. The bid price based on the learning rate, thus gives an advantage to the tendering firm in getting the order. Similarly, if the initial order is for 32 units, the price would be related to the still reduced time per unit, i.e. 2.62 hours.

In case of repeat orders, the bid price should be based on incremental average hours per unit. For example, if the initial order was for 16 units and a repeat order of another 16 units is received, the bid price will be based on the following :—

Cumulative average cost for 16 units	= 52.48 hours
Cumulative average cost for 32 units	= 83.84 hours

Incremental average cost for 16 units	= 31.36 hours
	= 1.96 hours per unit

If an order is cancelled before its execution is completed, the bidding firm having quoted on the basis of cost per unit for the ordered units will be put to a loss. For example, if an order for 16 units is cancelled at a stage when 8 units could be produced, the position will be :

Quotation based on contracted level of 16 units :	3.28 hours per unit
Actual execution of 8 units :	4.10 hours per unit

$$\text{Decremental loss} = \frac{(3.28 \times 16) - (4.10 \times 8)}{8} = 2.5 \text{ hours per unit.}$$

This points out to the necessity for making provisions in the contract for payment of compensation for such losses.

An example illustrating the fixation of bidding price on the basis of learning curve is given below :

EXAMPLE 18.1.

A company manufacturing small tools has just completed an order for 100 units of a made-to-order special tool for a structural construction firm at a contract price of Rs. 50,000. This firm has made enquiries for a repeat order for another 200 units of the special tool.

The cost details in respect of the first order are as follows :—

Per unit	Rs.
Labour	300
Material	50
Tools	10
Overhead	100 (20% Fixed)
	—
Cost per unit	Rs 460
Profit	40
	—
Price per unit	Rs 500

The company expects 80% learning rate in respect of labour and variable overhead but there will be a 10% escalation in these and material costs. The amount of Rs. 1,000 spent on tools will not be required for the second order. Not satisfied with the present rate of profit, the company desires to raise it to 20% on cost.

On the basis of the data given you are required to work out the contract price for the repeat order.

ANSWER .

The cost per unit subject to learning is as follows :—

Labour	Rs. 300
Variable overhead	80
	Rs. 380
Add 10%	38
Cost per unit for 100 units	Rs 418
Cost per unit for 200 units	Rs 418 × 0.8 Rs 334.4
Cost per unit for 400 units	Rs 334.4 × 0.8 Rs. 267.52

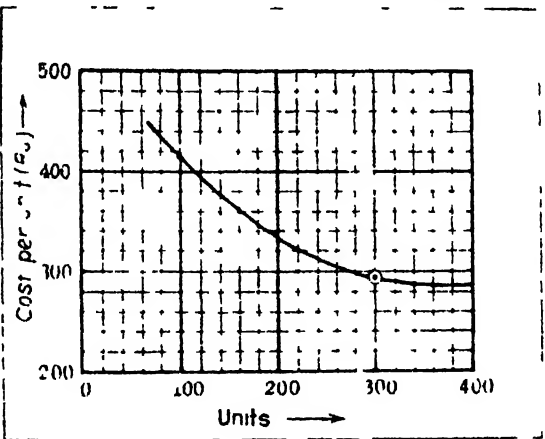


Fig. 18.4

The average cost per unit for 300 units (comprising the first order of 100 units and the repeat order of 200 units) may be computed with the help of a curve from the above three figures, viz. Rs. 418, Rs. 334.4 and Rs. 267.52 (see Fig. 18.4), or it may be calculated with the help of the formula as follows :—

$$\log Y = \log 418 - 0.3219 \times \log 3$$
$$= 2.6212 - 0.3219 \times 0.4771 = 2.4676$$
$$Y = 293.5$$

Cost of cumulative 300 units (293.5 × 300)	Rs. 88,050
Cost of first 100 units (Rs. 418 × 100)	41,800
Adjusted cost of second batch of 200 units	Rs. 46,250
	or Rs. 231.25 per unit

Price per unit for repeat order of 200 units

Labour and variable overhead	Rs. 231.25
Material (Rs. 50 + 10% of Rs. 50)	55.00
Fixed overhead (Rs. 2,000/200)	10.00
	<hr/>
Total cost	Rs. 296.25
Profit (20%)	59.25
	<hr/>
Price	Rs. 355.50
	or $\text{Rs. } 355.50 \times 200$
	= Rs. 71,100 for the order

(ii) *Work scheduling* : The learning curve concept assists the management in work scheduling and production control in three ways :

(a) It predicts man-hours and the workforce required for meeting the production plan so that timely action may be taken to procure the required workforce.

(b) It indicates the time required for production so that scheduled deliveries can be maintained.

(c) It enables production control to take advantage of reducing the time per unit of production by increasing the product lot sizes.

(iii) *Planning inventory* : The learning curve indicates how with increased efficiency of the worker, the pace of production increases consequent to which more materials are required and work-in-progress and finished goods stocks grow rapidly in size. Awareness of the growth rate enables the management to plan the inventories properly.

(iv) *Planning working capital* : When unit prices are based on average cumulative cost per unit, the cost of the first few units produced will be higher than the cost on which the bid price was based. As a result, the profit level may not be high enough to provide sufficient working capital. In such a situation, the learning curve will indicate the quantum of the shortage of working capital so that suitable action may be taken on time to meet the shortfall.

(v) *Make or buy decision* : The learning curve is useful in make or buy decision making. While purchasing from outside on long term basis, it is to be seen whether the supplier has already reached the maximum efficiency in which case no learning curve will apply and no reduction in price in future can be expected. In another situation where instead of purchasing, internal production is speeded up, new unexperienced workers may have to be employed resulting in high costs now but gradual lower costs may be expected when the improvement process operates.

HUMAN RESOURCE ACCOUNTING

Human Resources considered as Assets. *Human Resource Accounting* refers to the process of identification and measurement of data relating to *human resources* for the twofold purpose of financial reporting and managerial decision making. So far, conventional accounting system has recognised the revenue aspect of human resources under which wages, salaries, and other compensations paid to the personnel are charged to current costs but the value of the human resources do not appear in the Balance Sheet of a company. However, it is now being largely felt that, like any other resource, financial or physical, human resource should also

be considered as a capital asset of the business. The similarity between human resource and other assets and the need for human resource accounting will be obvious from the following considerations :—

- (i) Like any other asset, human resource provides benefit of economic value to an organisation, measurable in monetary terms.
- (ii) Human resource contributes to the efforts of management towards financial improvement and achievement of the goals of the organisation just as other resources do.
- (iii) Similar to other assets, human resource can be provided only at a cost. In many firms, huge sums of money are invested in providing human resources.
- (iv) Cost-benefit analysis of human resources is possible in the same manner as for the other accounting assets such as plant and machinery.
- (v) Like other long-term assets, human resource provides future benefits to the organisation.
- (vi) Just as the values of capital assets are subject to variations from time to time, due to additions, obsolescence, disposals, price level fluctuations etc., the value of human resource in an organisation also undergoes periodical changes due to similar factors.

Valuation of Human Resources. For the purpose of exhibiting in the financial accounts, human resources have obviously to be valued. Several methods of valuation of human resources have been suggested each of which relates to either of the two basic methods, viz. (i) cost based valuation and (ii) economic value based valuation.

A. Cost based valuation : The cost for the purpose of valuation may be either the acquisition or replacement cost of personnel in an organisation.

(i) *Acquisition and development costs method :* Under this method, the value of the human resources would consist of the costs of recruitment, various types of training including induction and orientation training, on-the-job training, and management development and experience, incurred for bringing the personnel upto a certain level of competence and capability. Such costs collected for each individual personnel constitute the human asset of the concern. The costs are capitalised and amortised over the expected working life of the personnel. If an employee leaves the company, the unexpired value of the related asset is written off as loss in the same way as is done for any other discarded physical asset.

It may be seen that the acquisition method (as also the replacement cost method, discussed below) is based on well known conventional accounting systems of dealing with capital assets and so it is easy to understand, develop and operate. The main disadvantage, as would be the case with any accounting system, is that the method deals with historical costs and is, therefore, not suitable for decision making.

(ii) *Replacement cost method :* In this method, instead of historical costs, replacement costs are adopted. Replacement cost for the purpose is the cost that would be incurred to replace a person by another possessing the same capabilities. Most accountants are of the view that besides the costs of acquisition and development, the replacement costs should also include the termination costs of the individual going out. The replacement cost may be based on management estimates or on the rates prevailing in the employment market.

The main advantage of the replacement cost method is that since the data relate to the present, no estimates of the future costs are necessary for calculating the human resource value. The limitation of the method is that it is not possible to have a suitable measure for the values of individual employees. Further, the knowledge and loyalty of an employee built over time cannot be properly reflected in the replacement value.

B. Economic value based valuation : There are various methods of estimating economic value, sponsored by different authors, which range from very simple methods to complex mathematical models. The earliest and one of the simplest method is the *unpurchased goodwill model*. Under this method, the value of the human resources is taken as the difference between the capitalised value of the earning of the firm over the normal earning in the industry of which the firm forms a part. If for instance, a company with an owned capital of Rs. 10 lakh earns a return of 15% in a particular year as against the industry's average return of 12% over a number of years, the value of human resource will be calculated as follows :—

Return at 15% Rs. 1,50,000

At the average rate of 12%, Rs. 1,50,000 would be earned from a capital of Rs. 12,50,000

The difference between Rs. 12,50,000 and Rs. 10,00,000, i.e. Rs. 2,50,000 is treated as human resource value.

The method has obvious fallacies since it will not be correct to assume that the excess earning results only by the applications of human resources, ignoring several other contributing factors. To carry the argument further, earning for a year going below the industry's average would mean that the human resource value is nil or even, negative.

Another method of determining the economic value of human resource has an opportunity cost approach. Under this method, the value is determined through a process of competitive bidding by profit centre managers for each employee or a group of employees. The bidding manager quotes the maximum amount which he is willing to pay for an employee ; the amount would obviously be limited to the benefit the manager expects to get or make out from the employee. In the ultimate analysis, a successful bidder would be the one who expects to get the maximum benefit from the employee bid for. The sum total of the maximum bid price, for the various individuals will be the computed value of the human resource of the organisation.

Though a mathematical model has been developed for the bidding method and it is, *prima facie*, based on an appealing concept, its application is limited and is workable only for a small sector of the total human resources of a company.

Yet another method of determining the economic value of human resource is based on the present value of the future earning of the organisation. The method involves the estimation of the net present value of the future benefits to be provided by an individual employee. The estimate includes the total life span of the individual, the various positions likely to be held by him from time to time, the probabilities associated with the occupation of each such position and measurement of the value of benefits obtainable from the various positions in

different periods. A mathematical formula suggested by the authors of this method is :

$$E(V_y) = \sum_{t=y}^T P_y(t+1) \sum_{t=y}^t \frac{I_1}{(1+r)^{t-y}}$$

- Where, $E(V_y)$ = Expected value of the human capital of a person, y years old
 t Retirement age of the person
 $P_y(t)$ Probability of the person leaving the organisation
 r Discount rate applicable to the person
 I_1 = Estimated earnings of the person during the period

The economic value method is theoretically sound but in practice, it is difficult to measure the benefits. There is no direct measure of the contribution that an individual makes to the profits of an organisation except in some isolated areas such as the sales division where a link can be established to some extent between the efforts of the salesmen and the company's earnings.

Advantages of Human Resource Accounting. The concept of human resource accounting has not yet been widely recognised in accounting circles mainly because it has not yet fully developed and the methods prescribed are yet to be tested in practice and standardised. Human resource accounting if properly implemented, has, however, a number of advantages to offer to a business organisation in the matter of reporting and decision making. The advantages are :

- (i) In the process of establishment of human resource accounting, the awareness of the importance of human resource contributions in the day to day activities of the organisation leads to improvement in the fields of communication, training programmes, employee turnover, and even production processes.
- (ii) It assists management in proper utilisation of human resources.
- (iii) Human resource accounting is helpful in managerial decision making.
- (iv) Reporting through inclusion in the Balance Sheet of large sums representing human resource capital has the effect of presenting complete information about the state of affairs of the company.

INFLATION ACCOUNTING

The Need for Inflation Accounting. Inflation has now come to stay as a standing feature in the economy of almost all the countries of the world. In the traditional methods of accounting, assets are carried over from one accounting period to another on the basis of acquisition prices without taking into account the effects of price changes occurring in the meantime. This results in serious deficiencies in profit measurement. Profit, as we know, is the outcome of matching costs with revenue ; the profit figure appears in the profit and loss account as the difference between the debits and credits. The profit figure is also calculated by comparing the figures in the opening and closing balance sheets after making suitable adjustments for capital additions, disposals etc. In either case, the cost data used for working out the profit contain certain amounts relating to the previous financial periods that are carried over to the current period. Since these are at the old (historical) prices, which in the meantime have been subject to inflation, the profit figure calculated on the conventional basis is distorted. Items like depreciation calculated on historical costs of capital assets, long-term assets and

inventory valued at old prices and other capital figures which do not include any allowances for the change in the purchasing power of money cause the distortion of profit and affect the accuracy of the profit figure.

Limitations of Historical Cost Accounting. The final accounts—the profit and loss account and the balance sheet—presented on the basis of historical costs have long been considered to give a true and fair view of the state of affairs of a company. In a situation as at present, when price changes in inputs as well as outputs are the order of the day, the limitations of historical cost accounting methods become very much relevant. The limitations (also referred to briefly, in the previous section) may be summarised as follows :—

1. Current revenues are matched with out-of-date costs. Basing input at historical cost and sales revenue at current increased prices results in stockholding gain which is reported as profit in the account.
2. When prices are rising, return on capital employed is overstated ; historical cost profit is inflated and the asset value is on the lower side so that the ratio between the two is pushed up.
3. Accounts based on historical costs do not show whether a company is earning sufficient funds on its capital, in the real terms.
4. Depreciation is provided in accounts in order to charge the consumption of fixed assets against the revenue derived from their use. With the change in the price of fixed assets, the amount of depreciation charged on the basis of historical costs of the assets does not correctly represent the revenue earned from the use of such assets.
5. Historical cost accounting gives a misleading impression of profitability growth ; this may result in over-distribution of dividends etc.

Accounting for the Effects of Changing Prices. While there is a widespread agreement among all accountants about the inadequacy and limitations of historical cost accounting when significant change in price takes place, the methods to be adopted for the accounting for the effects of price changes and their presentation in the final accounts and statements of a company have been a matter of debate and experiments for the past two decades or so by accountants throughout the world. Though much progress has been made to standardise the practice in this regard, the system of accounting is yet to take a final agreed form. The efforts made towards achieving a consensus may be studied by tracing the history of accounting for price changes in the U.K.

Although accountants were siezed of the problem much earlier, the subject of inflation accounting was taken up for serious examination in 1969 by the Accounting Standards Committee, whose prescriptions are valid only in the U.K. and Ireland. The Committee prepared a discussion paper, then an exposure draft and finally a provisional statement of standard accounting practice (PSSAP 7), *Accounting for Changes in the Purchasing Power of Money*, in 1974. The recommendations introduced a concept of accounting that came to be known as General Purchasing Power Accounting, described as Current Purchase Power Accounting by U.K. accountants. Since this concept was demolished in the U.K. even before it could take a start (as described in the next section), it would be pointless to go into the details of the General Purchase Power Accounting and the

criticisms levelled against it. However, since in some countries, the concept has found favour, a mention may be made of the some of the important recommendations made in PSSAP 7. These were :

- a. Companies will continue to keep their records and present their basic annual accounts in historical pounds, i.e. in terms of the value of the pound at the time of each transaction.
- b. In addition, all listed companies should present to their shareholders a supplementary statement in terms of the value of the pound at the end of the period to which the accounts relate.
- c. *The conversion of the figures in the basic accounts into the figures in the supplementary statement should be by means of a general index of the purchasing power of the pound.*
- d. The standard requires the directors to provide in a note to the supplementary statement, an explanation of the basis on which it has been prepared and it is desirable that directors should comment on the significance of the figures.

The conversion, referred to at above, is made in respect of the various figures relevant, with reference to the changes in a general price index (one of the general indices available in the country may be used) between the date of the original transactions and the end of the year to which the accounts and statements relate. Profit before taxation on historical basis is converted to current purchase power basis by adjusting :

Stock : Additional charge based on restating the cost of stock at the beginning and end of the year in terms of current purchase price.

Depreciation : Additional depreciation based on cost measured in terms of current purchase price of fixed assets.

Monetary items : Net gain in purchase price resulting from the effects of inflation on the company's net monetary liabilities.

Sales, purchase and other costs : Increased by the change in the index between the average date at which they are incurred and the end of the year.

It may be noted that except for the net gain in the net monetary liabilities, all the other adjustments have in case of price rise, the effect of increasing the historical profit before taxation.

The balance sheet items at the beginning and end of the year are converted in terms of current purchase price. Only non-monetary items (with the exception of total equity interest, i.e. share capital, reserves and retained profits), such as stock, plant and buildings are adjusted for the changes in the purchasing power. Monetary items such as cash, debtors, creditors and loan capital are not adjusted since their amounts are fixed in terms of contracts or otherwise.

Adjustments to be made under current purchase power method are illustrated in the example given below :

EXAMPLE 18.2.

In the context of inflation accounting system, adjust the following Profit and Loss Account and Balance Sheet under the 'Current Purchasing Power or (CPP)' method to ascertain the changes in Net Profit and Reserve.

Profit and Loss Account for the year ended 31.12.84

	Rs	Rs
Sales		5,00,000
Opening	80,000	
Purchases	4,20,000	
Less Closing Stock	70,000	4,30,000
	---	---
Gross Profit		70,000
Depreciation (Buildings)	5,000	
Administration	25,000	
	-----	30,000
Net Profit		40,000

Balance Sheet as on 31.12.84

	Rs	Rs
Share capital		200,000
Reserves		200,000

		4,00,000
Land		140,000
Building	200,000	
Depreciation	45,000	
	-----	1,55,000
Stock	70,000	
Debtors	40,000	
Cash	30,000	

	1,40,000	
Creditors	35,000	
	-----	1,05,000

		4,00,000

The following data are given :

- (1) Closing stock was acquired during last quarter of 1984 and opening stock during the last quarter of 1983.
- (2) The land and buildings were acquired and the capital issued during 1976. The buildings are depreciated straight line over 40 years.
- (3) The relevant retail price indices are :

(a) 1976 average	60
(b) 1983 last quarter average	108
(c) 1983 December 31	110
(d) 1984 last quarter average	116
(e) 1984 average	114
(f) 1984 December 31	118
- (4) Sales, Purchases and Administration expenses are assumed to occur evenly over the past year and hence at average prices.

(I.C.W.A., Final)

ANSWER :

Profit and Loss Account for the period ended 31.12.84

(Figures are in '000 Rs.)

		Adjustment factor		Adjusted on CPP Basis at 31.12.84
Sales	500	118/114		517.6
Opening Stock	80	118/108	87.4	
Purchase	420	118/114	434.7	
Closing Stock ()	70	118/116	(-) 71.2	450.9
	<hr/> 430			
	<hr/> 70			66.7
Gross Profit				
Depreciation	5	118/60	9.8	
Administration	25	118/14	25.9	
	<hr/> 30			35.7
Net Profit	<hr/> 40			<hr/> 31.0

Balance Sheet as at 31.12.84

(Figures are in '000 Rs.)

		Adjustment factor		Adjusted value on CPP basis at 31.12.84
Share Capital	200	118/60		393.3
Reserves	200			292.9*
	<hr/> 400			<hr/> 686.2
Land	140	118/60		275.3
Building	200	118/60	393.3	
Depreciation	45	118/60	88.6	304.7
	<hr/> 155			
Stock	70	118/116	71.2	
Debtor	40	1	40	
Cash	30	1	30	
Creditors ()	35	1	35	
	<hr/> 105			106.2
	<hr/> 400			<hr/> 686.2

Residual to balance : 686.2 minus 393.3 292.9

Current Cost Accounting. The U.K. government set up a committee headed by Mr. F.E.P. Sandilands to go into the proposal for current (general) purchase power accounting. The report of the Sandilands Committee, published in 1975, rejected the concept of current purchase power accounting and introduced, in its place, the concept of Current Cost Accounting. The report was discussed thoroughly in the accountancy and business circles; the Morpeth Steering Committee examined the concept and was instrumental in the preparation of ED18, Current Cost Accounting, published by ASC in 1976. The recommendation made in ED18 was, however, not acceptable probably because of its complex

nature. The Hyde Committee set up by the ASC produced simplified 'Guidelines' and eventually, SSAP16, *Current Cost Accounting* was published in 1980.

As a result of studies undertaken for the past several years, important changes have been proposed to SSAP 16 and incorporated in ED 35, published in 1984. The changes relate principally to the disclosure requirements of the standard rather than to the concepts of how to account for the effects of changing prices. A major deviation as recommended in the revised standard is that instead of preparing two separate sets of accounts, the information about the effect of changing prices should be shown in notes to the single set of accounts where it is not given in the accounts themselves. It is of interest, however, to note that current cost accounting has not been whole heartedly accepted and there is now a rethinking on the methods proposed.

Current cost accounting refers to the preparation, interpretation and uses of current cost information in the context of accounting for the effect of changing prices. Current cost is defined as, (a) net current replacement cost, or if there has been a permanent diminution in value to below net replacement cost, (b) recoverable amount.

Current cost accounting suggests that assets be measured at current cost, and the profit determined after providing for the operating capability of the business. (The operating capability of a business is the amount of goods and services which the business is able to supply with its existing resources. The resources or net operating assets comprise fixed assets, stocks and monetary working capital.) Under the concept of maintenance of operating capability, profit should be determined after allowing for the effects of specific price changes on the funds required to maintain the net operating assets (and thus operating capability of the business) taking into account the way in which these assets are financed.

The basic objective of current cost accounts is to provide more useful information than that available from historical cost accounts alone for the guidance of the management of the business, the shareholders and others on such matters as :

- (a) the financial viability of the business ;
- (b) return on investment ;
- (c) pricing policy, cost control and distribution decisions ; and
- (d) gearing.

Further extracts from ED 35 given in the following sections, explain the proposed standard practice of current cost accounting.

The financial statements of a public company should show the effects of changing prices on the operating capability and financing of the company by giving the following current cost information :

- (a) A depreciation adjustment : this is the difference between the charge for depreciation on the historical cost (or modified historical cost) profit and loss account and the charge calculated on a current cost basis.
- (b) A cost of sales adjustment : this is the difference between the charges for cost of sales calculated on a historical cost and on a current cost basis.
- (c) A monetary working capital adjustment : this is the increase in working capital required during the period (or the decrease possible during period, when current costs are falling) in order to maintain the operating capability of the net operating assets.

The cost of sales adjustment and monetary working capital may be calculated by reference to the average day-to-day working capital required, using appropriate indices. They represent the effect of price changes on the company's working capital requirements.

(d) A gearing adjustment : this is either of the following :—

- (i) that part of the adjustment made to allow for the impact of price changes on the net operating assets that may be regarded as associated with the items that are financed by net borrowing ;
- (ii) those parts of the total adjustments made to allow for the impact of price changes on the net operating assets including the net surplus on the revaluation of assets arising during the period, that may be regarded as associated with items that are financed by net borrowing ;
- (iii) the effect of general price changes on net borrowing (or net monetary assets other than those included in monetary working capital).

A gearing adjustment is needed to recognise the effect of debt capital. The net operating assets shown in the balance sheet are usually financed partly by borrowing and gearing adjustment is necessary for arriving at current cost profit attributable to shareholders. No gearing adjustment is required in case of companies wholly financed by shareholders' capital. While repayment rights on borrowing are normally fixed in monetary amount, the proportion of net operating assets so financed increases or decreases in value to business. In arriving at current cost operating profit, the operating adjustments initially made, make provision for the impact of price changes of all net operating assets, however financed. The gearing adjustment, therefore, abates the operating adjustments in the gearing proportion (i.e. in the ratio of net borrowing to the current cost of net operating assets) in deriving the current cost profit attributable to the shareholders. The gearing adjustment, subject to interest on borrowing, indicates the benefit or cost to shareholders which is realised in the period, measured by the extent to which a proportion of the net assets are financed by borrowing. The gearing adjustment may be shown as under :

Profit before interest and taxation on historical basis	Rs. 43,500
Less : Current cost operating adjustments	22,500

Current cost operating profit	Rs. 21,000
Gearing adjustment (-) Rs. 3,000 (-) Rs. 3,000	
Interest payable less receivable	3,500

Current cost profit before taxation	Rs. 20,500
Taxation	10,500

Current cost profit attributable to shareholders	Rs. 10,000

- (e) Any other material adjustments to the profit or loss on ordinary activities consistent with the current cost convention.
- (f) The effect of the above current cost adjustments on profit and loss on ordinary activities.
- (g) and (h) The current cost adjustment or adjusted amount in respect of (i) minority interests and (ii) extraordinary items.
- (i) The effect of all the above current cost adjustments on the profit or loss for the financial year.

The financial statements should show the gross and the net current cost of fixed assets and the accumulated current cost depreciation. The gross current cost of intangible assets and investments should be on the following basis :—

- (a) Intangible assets—at the best estimate of their current cost.
- (b) Goodwill—at cost at the date of acquisition.

The financial statements should also show the current cost of stocks.

The current replacement cost of fixed assets, other than intangible assets and goodwill, should be calculated as follows :

Land and buildings—at open market valuation certified by valuers.

Plant and machinery—by applying appropriate indices to the valuation or historical cost of each category of asset.

International Accounting Standards Committee and Price Change Accounting.
Practices with regard to the reporting of information regarding the effects of price

changes in accounts vary from country to country and no consensus has yet been arrived at nor will it be possible due to different requirements of each country. The *International Accounting Standards Committee* (of which the Institute of Cost and Works Accountants of India and the Institute of Chartered Accountants of India are Associate Members) published an exposure draft, ED 6, Accounting Treatment of Changing Prices, in 1976 followed by a Discussion Paper (1977) summarising the proposals made by the different member countries (including those of the U.K. referred to in the previous sections) and in the same year (1977), International Accounting Standard 6, Accounting Responses to Changing Prices was published. Thereafter, ED 17 and IAS 15, Information reflecting the effects of changing prices were published in 1980 and 1981 respectively. While accepting the divergent practices (mainly the GPP accounting and Current Cost accounting methods), IAS 15 lists the items which should normally be reported *on a supplementary basis* and recommends that 'enterprises should describe the methods adopted to compute the information called for including the nature of any indices used'.

In India, presentation of the effects of changing prices in the published financial statements has not yet found much favour and hardly two or three companies have made a start in this regard. Because of historical association with the U.K. in the accounting profession, the practice followed in that country, viz. Current Cost Accounting has been adopted with suitable modification to meet local conditions and the legal requirements of the country.

EXAMINATION QUESTIONS

1. In many manufacturing organisations cost reduction programmes are in being and one of the modern techniques of cost reduction is called 'value analysis'. Describe this technique and comment upon the management accountant's contribution to it.
(I.C.M.A., Part II)
2. Define 'Value Engineering'. Explain fully, with illustrations, how this concept may be applied usefully. Support your answer with suitable examples of a number of manufacturing situations (not less than three). (I.C.W.A., Management Accountancy)
3. What is the value? What is value analysis? Discuss how value analysis programme can be applied in a manufacturing organisation to bring down the cost of the product.
(I.C.W.A., Management Accountancy)
4. Purchase research, value analysis, and cost reduction are essential for survival especially in times of war and acute shortage of foreign exchange. Discuss. (I.C.W.A., Final)
5. What do you understand by cost reduction work? How does it contrast with value analysis work? "Appropriate cost reduction work is essential and is to be enlarged". State 5 different ways in which the yield of cost reduction throughout a plant may be improved by the aid of appropriate value analysis work. (I.C.W.A., Final)
6. What is the difference between cost control and cost reduction? Enumerate some of the possibilities in reducing the cost of a product and outline a programme for cost reduction. (I.C.W.A., Final)
7. As the Cost Accountant of a colliery, you are required to suggest programme of achieving a cost reduction of Rs. 2 per ton on the present budgeted cost of Rs. 20 per ton. Draft a report to the Management indicating broadly the steps to be taken to achieve this planned reduction. (I.C.W.A., Final)
8. Comment on the statement that 'no cost is such a satisfactory level that it cannot be reduced'. Mention a few of the areas in which cost reduction may be possible in a large industrial concern. (I.C.W.A., Final)

9. "Possibly the greatest scope for cost reduction throughout industry lies in the field of product design". (Cost reduction, I.C.W.A.,) Outline your ideas for cost reduction via the area of product design, with particular reference to :
 - (a) The improvement of existing design.
 - (b) The costs of variety.
 - (c) The use of the techniques of value analysis. (I.C.M.A., Part IV)
 10. Cost reduction is a continuous process embracing all the functions and divisions of a business. Outline the various critical areas of application of cost reduction and suggest the lines of approach you would make in a cost reduction plan. (I.C.W.A., Final)
 11. Of the various techniques employed for cost reduction, (a) Standardisation, (b) Simplification and Variety reduction and (c) Quality Control are the three methods which, simple and effective, are generally overlooked. Discuss the manner in which these methods operate in achieving substantial reduction in costs. (I.C.W.A., Final)
 12. High productivity is not incompatible with good quality, provided the cost of quality is fully met. Analyse the full range of quality costs, say for example, in the case of an engineering product from its inception. (I.C.W.A., Final)
 13. 'Productivity is the economy of means'. Explain and show how a budgetary cost control system helps to improve productivity. Indicate how productivity of labour and machine are measured. (I.C.W.A., Final)
 14. Explain the difference between production and productivity. Outline a system of presenting figures to management to illustrate the productivity within a business consisting of three separate departments, and show clearly how comparison with expected productivity is illustrated. (I.C.M.A., Final)
 15. Productivity can only be improved by paying attention to a variety of separate factors. What are these factors ? How would you apply them in a heavy constructions engineering firm, where the products manufactured are of different designs and dissimilar in nature ? Illustrate with an example. (I.C.W.A., Final)
 16. Discuss the role of a Cost Accountant in increasing the productivity of a manufacturing unit to which he is attached. (I.C.W.A., Final)
 17. 'Management by objectives provides a discipline and an opportunity to bring conflict area into the open in a constructive and cooperative atmosphere'. Discuss fully giving examples of conflict areas. Also, explain clearly what is meant by 'Management by Objectives' and state clearly how it is distinct from other management disciplines. (I.C.W.A., Management Accountancy)
 18. What do you understand by the concept of Learning Curve ? Explain its relevance in planning for profit. (I.C.W.A., Final)
 19. 'The most valuable of capital is that invested in human beings. In the light of this statement, bring out the significance of accounting for human resources. Explain briefly some of the obvious uses of Human Resource Accounting and the methods of evaluation in practice. (I.C.W.A., Final)
 20. Explain the limitations of Historical Cost Accounting and in relation to Inflation Accounting system explain clearly with suitable examples, (a) Cost of Sales Adjustment and (b) Gearing Adjustment. (I.C.W.A., Final)
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CHAPTER 19

QUANTITATIVE MANAGEMENT ACCOUNTING TECHNIQUES

Statistical and Mathematical Approaches to Business Problems. Statistical methods and simple mathematical models have long been in use to assist the management in planning and controlling business functions and in decision making, in particular. The introduction of the techniques of Operations Research coupled with the ushering in of the computer age, completely revolutionalised the methods used by the management and the analytical techniques of yesterday that were more qualitative in nature have now tilted to their quantitative forms. Quantitative analysis requires the application of statistical and mathematical tools, in howsoever complex form they may be, to maximise decision making effectiveness.

The management accountant cannot afford to ignore this trend. He has to make himself conversant with these analytical tools so that he can make the management aware where and how quantitative techniques should be utilised to improve business methods and the decision making process. Not that he is to take over the role of the specialist who is interested in dealing with highly complex mathematical theories and models but as the accountant managing the financial affairs of the business, he is expected to know how to use effectively the tools given to him by the specialist without bothering to find out how these tools have been prepared.

In the earlier chapters of this book, we have illustrated the application of some of the commonly used techniques of statistics and mathematics such as, use of probability concept, co-relation and regression analysis, statistical control charts, expected value approach, inventory models, discounted cash flow etc. In this chapter, we introduce some of the advanced quantitative approaches to business problems. The mathematical models illustrated are very simple and mainly hypothetical since real-life models are highly complex using a vast mass of data processed through the computer. The simple models given should, however, be sufficient for the purpose of the business management and the management accountant, who are more interested in the application of the models rather than in trying to find out how they have been built up.

DECISION MAKING UNDER RISK AND UNCERTAINTY

A decision maker makes a choice between alternative courses of action. Decisions may be made under three different types of situations depending on the extent of knowledge the decision maker has about the state of nature. Thus decision may be made under (i) conditions of certainty, (ii) conditions of uncertainty and (iii) conditions of risk. Before we discuss these, the following terminology related to decision making problems, should be properly understood :

1. *Action.* Actions represent the various alternatives available to the decision maker to choose from. For example, producing 100 units of a product per day may be one action but producing 200 units of the product per day will be another action or to take another example, two mutually distinct investment A and investment B may be two different actions. A feature of an action is that management has a control over it.

2. *Events.* These are the various states of nature that may occur. For example, the demand for a product may be 200 units per day (say, high) or it may be 100 units per day (say, low). Occurrence of an event related to a specific action has an influence on the payoff but unlike in the case of actions, management has no control over events.

3. *Payoff.* This is usually the utility (profit or any other monetary consideration) associated with each selected action and a specified event. Thus payoff is affected both by the action selected and the event occurring. A payoff table indicates the different profits generated with each combination of a specific action and a specific event.

4. *Probabilities.* These are associated with events and they represent the possibility of each specific event happening. The probability of an event occurring may lie anywhere between 0 and 1 but the sum total of the probabilities of a number of events associated with an action must add up to 1.

Decision Making under Certainty. In conditions of certainty, only one state of nature exists and the future is completely certain. In decision making under conditions of certainty, the outcome of the alternative actions are known and the action that generates the highest payoff is selected. The decision maker knows for certain what is going to happen and he selects the best action associated with the certain event.

In terms of probabilities, state of certainty occurs when the probability of a specific event happening is 1 and the probabilities of all other events occurring is 0. In such a case, the decision maker knows for certain about which event will occur. If the probabilities of the various events occurring fall between the range, more than 0 but less than 1, this would be a condition of uncertainty.

Decision making under certainty is not as simple as we usually think of. Although many routine decisions involve issues which are not of any significance, in situations where a large number of alternative actions are available, the problem baffles manual solution. For instance, the problem of allocating some 25 different jobs to say, 30 different machines, or selection of an optimal product mix for say, 30 products are not just trivial despite the conditions of certainty.

Decision Making under Uncertainty or Risk. Under conditions of uncertainty, there are more than one state of nature but there is no knowledge or there is insufficient information for estimating probabilities for the future events. Under conditions of risk, there are more than one state of nature but information is available for estimating probabilities for future events in a more objective manner. This distinction is however, too fine and for many, uncertainty and risk may mean one and the same thing.

In dealing with problems involving uncertainty where estimates of probabilities of future events cannot be made, there are two methods in common use, viz. Maximax criterion and Maximin criterion.

Maximax : This is an optimistic approach. First, the maximum payoff for each action is selected and then, the alternative which gives the maximum payoff within the group is chosen as the decision point. To illustrate this, let us consider the following payoff table :

		Events or States of nature (Demand)			
		High	Moderate	Low	Failure
Action or Decision maker's alternatives (Supply)	1 Low	<u>Rs. 70,000</u>	Rs. 35,000	- Rs. 30,000	- Rs. 60,000
	2 Moderate	<u>Rs. 1,00,000</u>	Rs. 4,000	- Rs. 5,000	- Rs. 1,20,000
	3 High	<u>Rs. 50,000</u>	Rs. 25,000	- Rs. 2,000	- Rs. 20,000

The payoff figures within the rings denote the maximum for each action. In this group, the maximum payoff, viz. Rs. 1,00,000 pertains to Action 2 and thus the alternative selected will be 'Moderate Supply'.

Maximin : This is a pessimistic approach. First, the minimum payoff for each action is marked off and from that group, the maximum payoff is selected. Thus in the previous payoff table, the minimum payoff is marked within the rectangular cages. The maximum for the group, i.e. () Rs. 20,000 relates to Action 3 and thus the choice will be for 'High supply'.

A realistic approach can be made by selecting a criterion between the maximax and maximin provided it is possible to specify by intuition or otherwise, the extent of optimism or pessimism. For instance, if in the above illustration, the management feels that it could take a fairly optimistic view and states that 6 out of 10 times, an optimistic view may be taken, the realistic values assigned to the three action alternatives will be :

Low	$6 \cdot \text{Rs. } 70,000 + .4 \cdot (- \text{Rs. } 60,000)$	Rs. 18,000
Moderate	$.6 \cdot \text{Rs. } 1,00,000 + .4 \cdot (- \text{Rs. } 1,20,000)$	Rs. 12,000
High	$.6 \cdot \text{Rs. } 50,000 + .4 \cdot (- \text{Rs. } 20,000)$	Rs. 22,000

The choice will be Action 3, High Supply, with an estimated payoff of Rs. 22,000.

Where meaningful probability estimates can be made for each event, the *expected value criterion* may be used for selecting the best alternative. The methodology for the use of expected value criterion was explained in Chapter 12, where the problem of investigating into variances was discussed.

In the computation of expected value, the decision maker may assign either objective probabilities or subjective probabilities to the events. Objective probabilities are those that are based on past experience or historical data and such probabilities can be assigned with a high degree of objectiveness. Subjective assignment of probabilities is made in cases where the decision maker has no past experience of occurrence of the events or where mathematical proofs of the probabilities are not available. The assignment of subjective probabilities would thus depend on the individual knack and judgement and as such, probabilities assigned by two individuals for the same set of events will rarely agree.

Some further statistical data are supplied to the decision maker to assist him in the evaluation of proposals under uncertainty and risk. The data given in the next page in respect of two mutually independent projects show that the expected value for each of the projects is the same.

Project I		Project II	
Cash flow	Probability	Cash flow	Probability
200	.1	300	.2
300	.2	350	.3
400	.4	400	.2
450	.2	450	.2
550	.1	500	.1

(Cash flows are in thousands of rupees)

Expected Values :

Project I : $.1 \cdot 200 + .2 \cdot 300 + .4 \cdot 400 + .2 \cdot 450 + .1 \cdot 550$
 $385 \text{ (Rs. 3,85,000)}$

Project II : $.2 \cdot 300 + .3 \cdot 350 + .2 \cdot 400 + .2 \cdot 450 + .1 \cdot 500$
 $385 \text{ (Rs. 3,85,000)}$

Since both the projects have the same cash flow, further information about the dispersion of the cash flow is required to be provided for decision making. This is done by calculating the standard deviation and the coefficient of variation, as illustrated below.

The standard deviation is the square root of the average squared differences between the expected value and the observations and is given by the formula,

$$\sigma = \left[\sum_{i=1}^n (X_i - E(X))^2 P X_i \right]^{1/2}$$

where $E(X)$ = Expected value, X_i = observation and PX_i = Probability of X_i .

For the two projects, the standard deviations are,

$$\begin{aligned} \text{Project I : } & \left[.1(200 - 385)^2 + .2(300 - 385)^2 + .4(400 - 385)^2 + .2(450 - 385)^2 \right. \\ & \left. + .1(550 - 385)^2 \right]^{1/2} = 92.33 \\ \text{Project II : } & \left[.2(300 - 385)^2 + .3(350 - 385)^2 + .2(400 - 385)^2 + .2(450 - 385)^2 \right. \\ & \left. + .1(500 - 385)^2 \right]^{1/2} = 63.44 \end{aligned}$$

The coefficient of variation measures the standard deviation as a percentage of the expected value and is used as a measure of relative dispersion to compare the dispersions of two or more alternatives,

$$\text{Coefficient of variation} = \frac{\text{Standard deviation}}{\text{Expected value}} \times 100$$

For the two projects, coefficients of variation are,

$$\text{Project I : } \frac{92.33}{385} \times 100 = 23.98\%$$

$$\text{Project II : } \frac{63.44}{385} \times 100 = 16.48\%$$

Since Project II has a smaller coefficient of variation, it would be selected.

Value of Additional Information. In many decision situations under uncertainty, it is possible to obtain further information about the estimated probabilities. The information may be perfect information so that the decision maker can have definite knowledge about which of the events will occur and in which case he can make a clear decision. The additional information costs money, e.g. further information may be obtained (i) by carrying out own market research or by purchase from outside market research agencies, (ii) by constructing a prototype model or (iii) carrying out pilot runs. The difference between the expected value as calculated with the original estimated probabilities

and the expected value re-calculated after changing the probability estimates in the light of the additional information obtained is compared with the cost of obtaining the additional information. For example, if the expected value works out to Rs. 1.5 lakh on the basis of probabilities assessed on the present available information but if with additional information (which we take as perfect information), the expected value is improved to be Rs. 2 lakh, the cost of perfect information will be as follows :—

Expected value (with perfect information)	= Rs. 2,50,000
Expected value (without additional information)	= Rs. 1,50,000
Value of perfect information	= Rs. 1,00,000

If the cost of obtaining additional information is more than Rs. 1 lakh, the decision maker will not go for it.

Two important points about perfect information should be noted. First, obtaining perfect information does not change the course of an event nor does it assure any higher payoff. It simply points out to the occurrence of an event so that decision may be taken under certainty. The other point is that perfect information is not usually available and the additional information which a decision maker obtains is mostly imperfect. Even with the imperfect information, the estimated probabilities are revised and revised expected value calculated. The difference between the two expected values, i.e. with imperfect information and without information is calculated as in the case of perfect information. This value will be the maximum that the decision maker would be willing to pay for the information. Perhaps for imperfect information, he may be only willing to pay much less because the imperfect information does not provide him with complete knowledge.

Risk and Capital Investment Decisions. One of the basic requirements of capital investment decision making is to project all cash flows with a reasonable degree of accuracy. But since cash flows cannot be always forecast with certainty, there is considerable risk involved in most investment decision making problems. More the uncertainty, the greater is the risk involved in an investment decision ; the increased risk results from conditions over which the decision maker has almost no control.

The risk may be reduced by either obtaining more information (sometimes at a high cost because capital projects being mostly long-range and unique, not much historical data are available internally) or by avoiding those alternative projects that have the possibility of large losses. Several methods are applied for adjusting for risk and uncertainty in capital investment decisions. Some of these are discussed below :

1. *Desired rate of return* : In the application of the technique of discounting to obtain a present value of a project, the desired rate of return is fixed at a level dependent on the riskiness of the project. With higher rates of risk, higher rates of interest may be used. For example, let us consider a case of three alternative projects with different degrees of risk. The management considers one of the projects to have low risk and thinks that a rate of interest of 10% per annum would suffice ; for the second project considered to involve a moderate risk, a higher rate of 16% per annum is fixed and for the third project involving high risk, a still higher rate of 22% is desired.

2. *Payback periods* : Uncertainty and risk may be less in the case of projects with shorter payback. A short payback say, of 2 or 3 years has a reduced element of uncertainty and cash flows may be forecast more accurately. Sometimes, a project with high risk but short payback may be preferred to a project with low risk but longer payback, based on the consideration that cash flows in the early life of a project are more important.

3. *Estimation of probabilities* : In this method, risk and uncertainty are taken care of by estimating the probabilities of the different cash flows. Usually three estimates of the future cash flows for each year for each alternative project are made, viz. optimistic estimate, most likely (or best guess) estimate, and pessimistic estimate. For each of these estimates, subjective (i.e. likely) probabilities are assigned and the cash inflow for each year is computed as follows :

Let us consider the following estimates made in respect of the cash flow for a project whose life is assumed to be 4 years :

	Optimistic Rs.	Most likely Rs.	Pessimistic Rs.
Year 1	16,800	16,800	16,800
Year 2	1,30,000	98,000	28,000
Year 3	1,90,000	84,000	14,000
Year 4	2,10,000	90,000	12,000

If the estimated probabilities are :

Optimistic cash flow	: 2 out of 10, i.e. 0.2
Most likely cash flow	: 5 out of 10, i.e. 0.5
Pessimistic cash flow	: $1 - (.2 + .5) = 0.3$

The cash flow recasted for each year on the above basis will be :

Year 1 : (Rs. 16,800 \times .2) + (Rs. 16,800 \times .5) + (Rs. 16,800 \times .3) = Rs. 16,800
Year 2 : (Rs. 1,30,000 \times .2) + (Rs. 98,000 \times .5) + (Rs. 28,000 \times .3) = Rs. 83,400
Year 3 : (Rs. 1,90,000 \times .2) + (Rs. 84,000 \times .5) + (Rs. 14,000 \times .3) = Rs. 84,200
Year 4 : (Rs. 2,10,000 \times .2) + (Rs. 90,000 \times .5) + (Rs. 12,000 \times .3) = Rs. 90,600

Further investment analysis will be made on the basis of the above projected cash flows.

4. *Pessimistic approach* : In order to play safe, some managements prefer to adopt only the pessimistic predictions of cash flow.

5. *Sensitivity analysis* : This technique (already discussed in Chapter 16) may be used to measure the effect on the internal rate of interest or net present value of likely changes in any of the predicted variables, such as cash flow, operating costs, useful life of the capital asset etc.

Cost-Volume-Profit Analysis under Uncertainty. In our discussion of cost-volume-profit and break-even analysis in an earlier chapter, we had assumed a simplified relationship in which cost, volume and unit price were assumed to be more or less certain. We had also seen that such an assumption was not realistic. In real life situations, the selling prices and the related costs, volume and the profit estimated for a future period are not deterministic so that correct analysis cannot be made unless the conditions of uncertainty and risk are taken into account.

Statistical techniques are widely used to relax the assumptions made in cost-volume-profit analysis and work out the impact of uncertainty. The first step in the application of statistical techniques is to determine the probability

distribution of the related variables (i.e. the sales volume, selling prices, costs and profits) ; this may based on the study of past data, if available or by intuition. Although the distribution may take any pattern, we may assume for the purpose of our simple understanding of the problem that cost-volume-profit relationship usually follows the *normal distribution* pattern.

A normal distribution curve is shown in Fig. 19.1. μ and σ denote the mean and standard deviation respectively of the distributions. The values of μ (which centres the curve) and the value of σ (which determines the spread of the curve), completely determine the location and shape of the curve. The area under the curve, for practical purposes, sums to one and since the curve reaches a maximum of the mean of the distributions, one half of the area lies on either side of the mean. The entire area lies between $\pm 3\sigma$ and the areas bounded by $\pm \sigma$, $\pm 2\sigma$ and $\pm 3\sigma$ are as follows :—

Area between $(\mu - \sigma)$ and $(\mu + \sigma)$ = 68.27% (34.134% on either side)

Area between $(\mu - 2\sigma)$ and $(\mu + 2\sigma)$ = 95.45% (47.725% on either side)

Area between $(\mu - 3\sigma)$ and $(\mu + 3\sigma)$ = 99.73% (49.865% on either side)

In general, if a point X on the axis of a normal curve (mean = μ and standard deviation = σ) corresponds to a point Z on the standard normal curve, X is Z standard deviations to the right or left of μ according as Z is positive or negative. The relationship between the points is thus given by the formula,

$$X = \mu + Z\sigma, \text{ or } Z = \frac{X - \mu}{\sigma}$$

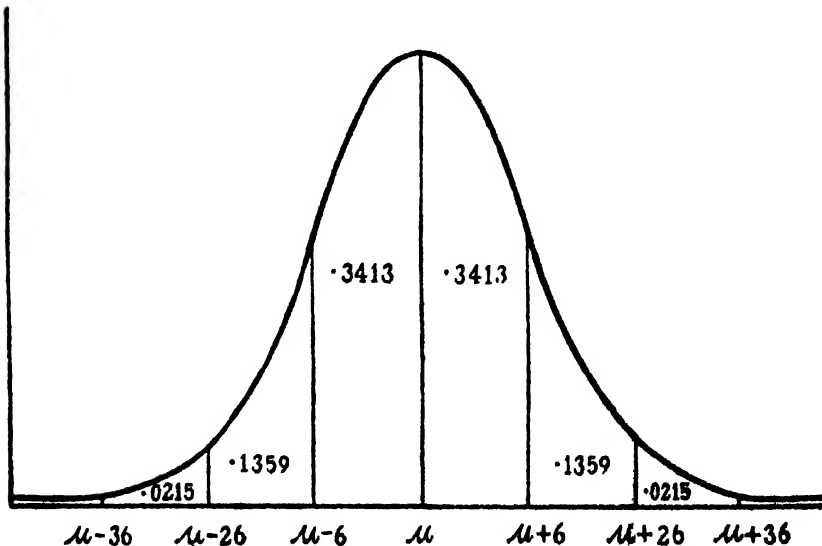


Fig. 19.1. Normal Distribution curve

With the above formula, we can find the point Z on the standard normal curve (in which μ is at 0 and σ is 1) that corresponds to any point X on a non-standard normal curve. Tables are available (one such table may be seen in the Appendices (Table 1) at the end of this book) for finding the area under any part of the normal curve for the variable Z . The value of Z so found out gives the probability of an event of a given random variable.

Application of normal probability distribution in cost-volume-profit analysis will be better understood from the following example.

EXAMPLE 19.1.

A company manufactures three products, A, B, and C, each one of which is a minor variation of the other. Each product has the same selling price, sales quantity, and variable and fixed costs and thus identical break-even units, as follows :—

Sales quantity	500 units
Selling price	Rs. 400 per unit
Variable cost	Rs. 200 per unit
Fixed cost	Rs. 50,000
Break-even	250 units

It was, however, seen that though the above data which were assumed to be expected mean for each of the products, the variability of the factors that generated the profit was different for each of the products. The standard deviations were estimated as follows :—

	Standard deviation
Product A	Sales quantity — 150 units
Product B	Selling price — Rs. 80
Product C	Variable cost — Rs. 100

Assuming that all the other factors in respect of a particular product except the one indicated above were certain estimates, and further assuming normal distribution for the variability for each product, make out a probability cost-volume-profit analysis indicating the probabilities of :

- at least break-even ;
- profit greater than Rs. 1,00,000
- loss greater than Rs. 40,000

On the basis of the results arrived at by you, indicate your recommendations if a choice is to be made among the three products.

ANSWER :

Sales revenue	Rs. 2,00,000
Variable cost	Rs. 1,00,000
Marginal contribution	Rs. 1,00,000
Fixed cost	Rs. 50,000
Profit	Rs. 50,000

Probability analysis for Product A

Mean profit (μ) — Rs. 50,000

Standard deviation of profit (σ) = $\frac{\text{Rs. 1,00,000}}{500} \times 150 \text{ units} = \text{Rs. 30,000}$

$$(i) \text{ Probability of atleast break-even (Z)} = \frac{x - \mu}{\sigma} = \frac{0 - \text{Rs. 50,000}}{\text{Rs. 30,000}} = -1.667$$

From tables, $Z = -1.667$ represents $(0.5000 - 0.4525) = 0.9525$ of area
Probability = 95.25%

(ii) Probability of profit greater than Rs. 1,00,000

$$Z = \frac{\text{Rs. 1,00,000} - \text{Rs. 50,000}}{\text{Rs. 30,000}} = 1.667$$

which represents $(0.5000 - 0.4525) = 0.0475$ of area Probability = 4.75%

(iii) Probability of loss greater than Rs. 40,000

$$Z = \frac{(-) \text{Rs. 40,000} - \text{Rs. 50,000}}{\text{Rs. 30,000}} = -3,$$

which represents $(0.5000 - 0.4987) = 0.0013$ of area Probability = 0.13%

Probability analysis for Product B

Standard deviation of profit = Rs. 80 × 500 units = Rs. 40,000

- (i) Probability of atleast break-even ;

$$Z = \frac{0 - \text{Rs. } 50,000}{\text{Rs. } 40,000} = -1.25$$

representing $(0.5000 + 0.3944) = 0.8944$ of area

Probability = 89.44%

- (ii) Probability of profit greater than Rs. 1,00,000 ;

$$Z = \frac{\text{Rs. } 1,00,000 - \text{Rs. } 50,000}{\text{Rs. } 40,000} = 1.25,$$

representing $(0.5000 - 0.3944) = 0.1056$ of area

Probability = 10.56%

- (iii) Probability of loss greater than Rs. 40,000 ;

$$Z = \frac{(-) \text{Rs. } 40,000 - \text{Rs. } 50,000}{\text{Rs. } 40,000} = -2.25,$$

representing $(0.5000 - 0.4878) = 0.0122$ of area

Probability = 1.22%

Probability analysis for Product C

Standard deviation of profit = Rs. 100 × 500 units = Rs. 50,000

- (i) Probability of atleast break-even ;

$$Z = \frac{0 - \text{Rs. } 50,000}{\text{Rs. } 50,000} = -1,$$

representing $(0.5000 + 0.3413) = 0.8413$ of area

Probability = 84.13%

- (ii) Probability of profit greater than Rs. 1,00,000 ;

$$Z = \frac{\text{Rs. } 1,00,000 - \text{Rs. } 50,000}{\text{Rs. } 50,000} = 1,$$

representing $(0.5000 - 0.3413) = 0.1587$ of area

Probability = 15.87%

- (iii) Probability of loss greater than Rs. 40,000 ;

$$Z = \frac{(-) \text{Rs. } 40,000 - \text{Rs. } 50,000}{\text{Rs. } 50,000} = -1.8,$$

representing $(0.5000 - 0.4641) = 0.0359$ of area

Probability = 3.59%

The above results are tabulated as follows :—

Mean Profit	Products		Ranking
	A	B	
Standard deviation of profit	Rs. 50,000	Rs. 50,000	Rs. 50,000
Probability of :	Rs. 30,000	Rs. 40,000	Rs. 50,000
(i) at least break-even	95.25%	89.44%	84.13%
(ii) profit greater than Rs. 1,00,000	4.75%	10.56%	15.87%
(iii) loss greater than Rs. 40,000	0.13%	1.22%	3.59%

It will be seen from the table that :

- Product C is most risky since probability of its break-even is the lowest and the probability of loss greater than Rs. 40,000 is the highest ;
- On the basis of the argument at (a) above, Product A has the least risk ;
- Product C is most profitable since the probability of its generating profit greater than Rs. 1,00,000 is the highest ;
- For the same reason as at (c) above, Product A is the least profitable.

In the circumstances, the choice between the three products will depend upon the management's attitude towards risk. For example :

- If it is decided that probability of loss greater than Rs. 40,000 will not be acceptable if it exceeds 1%, Products C and B are to be discarded ;
- If profit greater than Rs. 1,00,000 is desired, Product C will be selected ;
- If higher profits are desired but at the same time it is considered that the probability of loss greater than Rs. 40,000 should not be more than 1.25%, Product B will be selected.

Cost-volume-profit analysis through simulation. In the stochastic method of analysis discussed above, normal distribution of the probabilities is assumed. The illustration is made simpler by further assuming that the factors, viz. selling price, sales quantity and fixed and variable costs, are mutually independent and standard deviation for only one factor at a time is considered. In real situations where the factors have probability distribution pattern other than normal and where they are mutually dependent, the procedure of *Simulation* (discussed in another section of this chapter) is used.

Uncertainties in respect of all the factors are incorporated in the simulation process simultaneously. Instead of one single estimate, the most likely value and the expected variability about that value is specified in respect of each factor. Parameters are specified and with the help of the computer, random selection of each factor is made for a very large number of iterations. At the end of the iteration process, the mean and the standard deviation for all the observed profit amounts are assessed to arrive at the likelihood of the various levels of profit.

Investigation of Variances. We had discussed in Chapter 12, the various methods of analysing variances. Since the making of analysis of variances costs money, not all variances are investigated and management takes up only the significant variances for probing. As a common practice, minor deviations from budgets and standards and random or chance variances are not considered for investigation. A cost-benefit analysis is necessary to decide whether or not an item should be taken up for detailed analysis and investigation. The costs of investigation consist of, (i) cost of investigating a variance, and (ii) cost of action taken to correct the process and to bring it back in control. The benefit is represented by the cost of allowing the process to continue as it is, i.e. in an out-of-control. Investigation is taken up only if the cost of allowing the present state to continue exceeds the costs of investigation and correction.

Three different methods to decide whether a variance should be investigated are discussed in the following sections.

(i) *Managerial intuition and judgement* : Most companies prescribe limits of variances expressed as, (i) absolute rupee amount, or (ii) percentage of budget amount, or both, as guidelines for investigation. Variances falling within the limits are considered to be in-control state and hence not investigated. Variances beyond the limits are out-of-control variances that need investigation. The practice in some companies is to prescribe such limits separately for each element of costs and for revenue.

The limits are not fixed arbitrarily but are based partly on historical experience and partly on intuition. The basic assumptions are that variances within the limits fixed will be in-control and that the costs of investigation of such variances and bringing back the process into control will be higher than the cost of allowing the present state to continue.

The intuition method is simple and inexpensive and though not statistically justified like the other two methods described below, the limits, if fixed with proper care, may be reasonably accurate.

(ii) *Expected Value method* : In this method, the probabilities of a variance being

in out-of-control and in-control states are estimated and a payoff matrix is formed in the manner shown below :

Action	Probability	State	
		In-control	Out-of-control
		P_1	P_2
Investigate, a_i		C_i	$C_i + C_c$
Do not investigate, a_0		0	C_b

P_1 = Probability associated with in-control state

P_2 = Probability associated with out-of-control state

C_i = Cost of investigation

C_c = Cost of bringing back the process in-control

C_b = Cost of allowing the out-of-control state to continue.

a_i = Value of the action to investigate

a_0 = Value of the action not to investigate

From the pay-off matrix, we find that,

Expected value, $a_i = P_1 C_i + P_2 (C_i + C_c)$, and

Expected value, $a_0 = P_1 \times 0 + P_2 C_b$

If, $a_i > a_0$, the decision will be not to investigate ;

$a_i < a_0$, the decision will be to investigate ;

$a_i = a_0$, the management will be indifferent, i.e. it would be immaterial whether or not the variance is investigated.

When $a_i = a_0$, $P_1 C_i + P_2 (C_i + C_c) = P_2 C_b$

But $P_1 + P_2 = 1$, or $P_1 = 1 - P_2$

Therefore, $(1 - P_2) C_i + P_2 (C_i + C_c) = P_2 C_b$

$$\text{or, } P_2 = \frac{C_i}{C_b - C_c}$$

In the above situation, P_2 becomes the break-even probability which indicates that the decision will be to investigate only if the estimated probability of the out-of-control state is greater than the break-even probability, viz.

$$\frac{C_i}{C_b - C_c}$$

This may be illustrated by assigning numerical values to the symbols. Let us assume that,

C_i	= Rs. 300	P_1	= 0.85
C_c	= Rs. 2,000	P_2	= 0.15
C_b	= Rs. 5,000		

The break-even probability will be equal to

$$\frac{C_i}{C_b - C_c} = \frac{300}{5,000 - 2,000} = 0.10$$

Since P_2 (0.15) is higher than be break-even probability, the decision will be to investigate. This will be evident from the following, where $a_i < a_0$:

Expected value, $a_i = 0.85 \times 300 + 0.15(300 + 2,000) = \text{Rs. } 600$

Expected value, $a_0 = 0 + 0.15 \times 5,000 = \text{Rs. } 750$

The limitation of the expected value method arises mainly from the following :—

- (i) Estimation of the value of probability distribution for out-of-control state is difficult.
- (ii) It is difficult to calculate the value of C_b , the cost of allowing the out-of-control state to continue.
- (iii) *Statistical Control Chart method* : Statistical Quality Control is based on the concept that repetitive processes are subject to a certain amount of chance variability which has a stable pattern. A process is said to be in-control if all measurements fall within this pattern of variability. Items outside the pattern are in out-of-control state needing investigation. Thus if we build up the parameters within which a standard or budgeted cost item should vary, we can find out whether a variance should or should not be investigated.

The range of variation expected in an in-control state may be presented graphically in a statistical control chart (X chart) as shown in Fig. 19.2. The horizontal line in the middle in the chart indicates the expected average (which represents the standard or budget) and the upper and lower lines are the upper and lower limits of the expected variation, the range between the two lines representing the range of variation. The chart is constructed in the manner illustrated in the following section, with assumed figures.

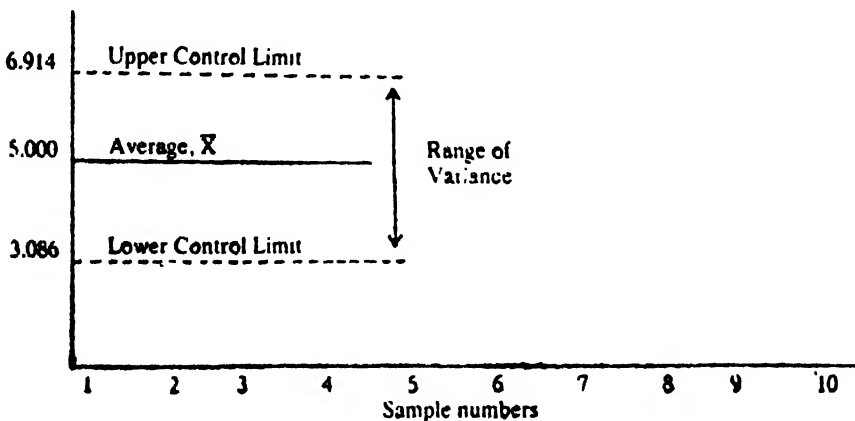


Fig. 19.2. Control Chart (\bar{X} Chart)

We start by making a number of observations. For instance, we may observe

the labour hours for one unit of an operation for 10 days (sample number = 10) by taking 5 units per day (sample size = 5) and record them as follows :—

Sample No.	Labour Hours per Unit					Sample Average	Sample Range
	Observations (Sample size, 5)						
	1	2	3	4	5		
1	3	5	4	5	5	4.4	2
2	5	4	7	6	6	5.6	3
3	3	5	7	4	5	4.8	4
4	4	7	4	4	5	4.8	3
5	6	4	7	4	3	4.8	4
6	7	5	7	3	6	5.6	4
7	5	5	3	5	6	4.8	3
8	7	6	4	5	4	5.2	3
9	4	5	5	4	7	5.0	3
10	3	4	6	7	5	5.0	4
						50.0	33
						5.0 Hrs.	3.3 Hrs.
						(\bar{x})	(R)

For sample 1, Sample average = $(3 + 5 + 4 + 5 + 5)/5 = 4.4$ hours,
 Sample range = $5 - 3 = 2$ hours,
 and so on for other samples.

Average of sample average, $\bar{\bar{x}} = 50.0/10 = 5.00$ hours

Average of sample range $\bar{R} = 33/10 = 3.30$ hours

$\bar{\bar{x}}$ is now posted on the chart as the middle line (Fig. 12.9).

The next step is to determine and draw the upper and lower limits. Assuming normal distribution for the sample averages, the observations falling within 1, 2 and 3 deviations will be :

$$x \pm 1\sigma = 68.3\% ; \bar{x} \pm 2\sigma = 95.5\% ; \bar{x} \pm 3\sigma = 99.7\%$$

In practice, the use of $\bar{x} \pm 3\sigma$ is common. From statistical tables, we may obtain the factor A_2 for different sample sizes for calculating three-sigma (3σ) control limits, using the average range, R . For sample size 5, $A_2 = 0.58$. Therefore,

$$\text{Upper Control Limit} = \bar{\bar{x}} + A_2\bar{R} = 5.00 + 0.58 \times 3.3 = 6.914 \text{ hours}$$

$$\text{Lower Control Limit} = \bar{\bar{x}} - A_2\bar{R} = 5.00 - 0.58 \times 3.3 = 3.086 \text{ hours}$$

After having constructed the control chart in the above manner, future observations are posted therein.

Investigation of variances will be made when :

- an observation falls beyond the control limits ; or
- though within the limits, it appears to be abnormally situated compared to the rest of the observations ; (most observations, though within the range, cluster close to one of the control limits) ; and
- the observations show a trend of going out of the control range, suggesting an out-of-control state in future.

DECISION TREE

A *decision tree* presents graphically, relevant information relating to a problem in the form of tree diagram, with the branches or forks and nodes, so as to assist the management in decision making. The decision tree presents the set of all possible actions, i.e. the decision points that are known variables, the uncertain or chance events, the uncertainty associated with each chance event, estimated in terms of probability of each, and the costs and revenues of each chance event.

The nodes in the tree diagram represent points in time where one of the following may occur :

- (i) One or another decision is required to be made by the decision maker ;
- (ii) The decision maker faces one or other state of nature ;
- (iii) The process ends.

Out of the nodes emerge, either a branch for each possible decision or a branch for each possible state of nature and under each branch, the probability of the corresponding event is defined and written

Once a decision tree has been constructed incorporating the probabilities of alternative decisions and related costs and revenue associated with each, the management may finalise the best decision which the firm has to take. An illustration of a simple tree diagram is shown in Fig. 19.3. The method of construction of the diagram is explained in the example given below :

EXAMPLE 19.2.

Geological Survey Co. Ltd. is often required to plan its future programme under-conditions of uncertainty. It has received an offer to bid for a preliminary exploration programme which is estimated to cost Rs. 10 lakh and generate a revenue of Rs. 20 lakh. There is a 50% chance of winning the bid and if successful, it offers the opportunity to bid for drilling programme which is the next stage after preliminary exploration. The drilling contract will yield a net profit of Rs. 60 but the chance of obtaining it depends upon the efforts made in this regard by the company. The chance pattern of the efforts is as follows :—

Effort	Cost involved	Probability of success in bid
A	Rs. 5 lakh	0.5
B	Rs. 8 lakh	0.7
C	Rs. 15 lakh	0.8

The Company has two other choices, viz. (i) to bid for the drilling contract even if it loses the preliminary exploration bid, and (ii) bid only for the drilling without entering into the bid for the preliminary exploration programme. The cost and probabilities related to each of the above two decisions will be as follows :—

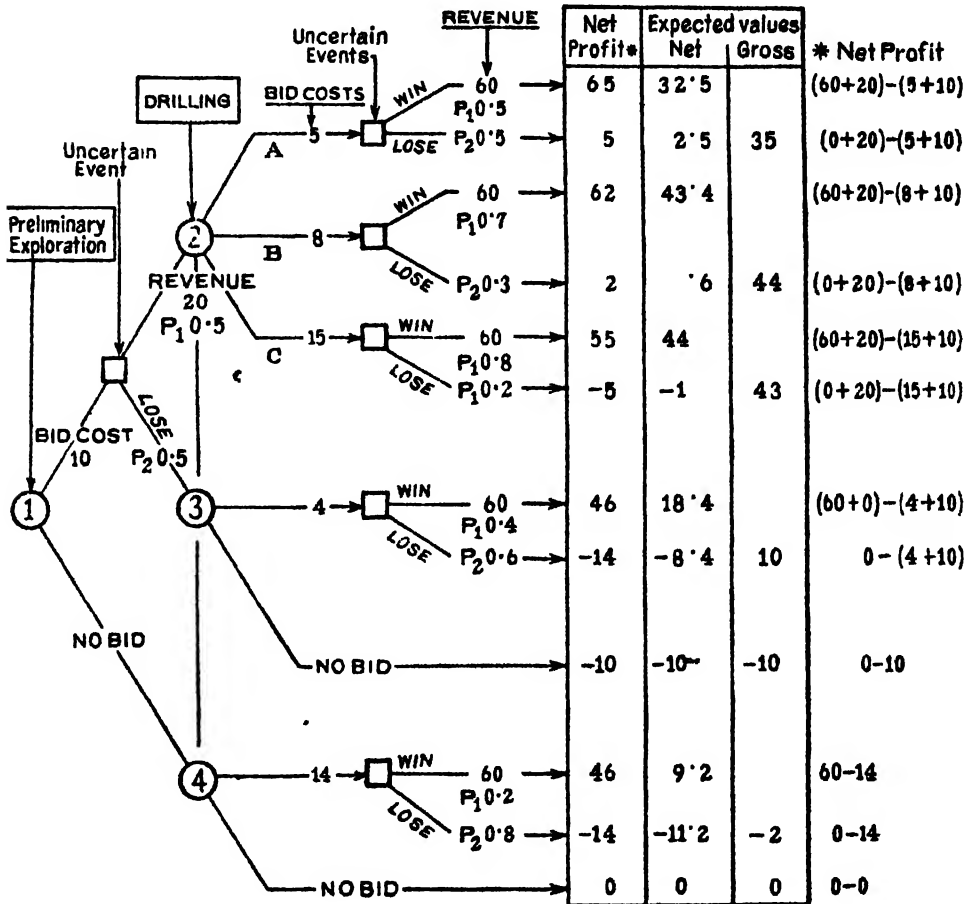
Decision	Cost involved	Probability of winning the contract
(i)	Rs. 4 lakh	0.4
(ii)	Rs. 14 lakh	0.2

You are required to construct a suitable tree diagram to assist the management in decision making. Also state the best decision which the company should take.

ANSWER :

With the data given, the decision tree is drawn as shown in Fig. 19.3 starting with decision point 1, viz. either to bid on the preliminary exploration programme or not to bid, each represented by the first two branches of the tree. The decision to bid results in two chance events, viz. win or

lose. If the bid is won, there is a branch to the next decision point, i.e. either to bid for drilling contract or not to bid. The process of construction of the tree is continued in this manner till all the decision points and chance events are included in the diagram. On the given tree diagram, the circular nodes indicate the decision points and rectangular nodes are the uncertain chance events. The costs/revenues related to each decision and the probability of each chance event are noted against each branch.



(ALL COSTS AND REVENUES ARE IN RS. LAKH)

Fig. 19.3. Decision Tree

The optimal decision is arrived at by making a start at the terminal nodes and move backwards through the network, calculating the expected profits (or gains) at the intermediate nodes. For the first terminal node,

Win

Revenue	=	$60 + 20$	=	Rs. 80 lakh
Cost	=	$10 + 5$	=	Rs. 15 lakh
Net profit	=		=	Rs. 65 lakh
Expected net value of gain	=	65×0.5	=	Rs. 32.5 lakh

Lose

Revenue	=	$0 + 20$	=	Rs. 20 lakh
Cost	=	$5 + 10$	=	Rs. 15 lakh
Net profit	=		=	Rs. 5 lakh
Expected net value of gain	=	5×0.5	=	Rs. 2.5 lakh

Gross expected value = Rs. 32.5 lakh + Rs. 2.5 lakh = Rs. 35 lakh

The net profits, net expected values and gross expected values for the other nodes are calculated in a similar manner and noted in the cage against each node, as shown in the diagram.

The recommended decision will be the one that leads to the maximum expected gain (gross). In the given problem, the best decision will be to bid for the preliminary exploration and if that is won, to continue with effort B and bid for the drilling work which will generate a gross expected value of Rs. 44 lakh (i.e. the maximum in the tree). If the first bid is lost, the decision will be to bid for the drilling contract, which will result in a gross expected value of Rs. 10 lakh.

Decision tree offers the following advantages :—

- (i) It is useful for arriving at the optimum decisions for complicated processes particularly when the decision problems are inter-related and sequential in nature.
- (ii) Decision problems may be viewed in a systematic perspective and in totality when a decision at each time is dependent on the decision made at the previous and following time periods.
- (iii) Decision tree focuses attention on the critical elements in a decision process.
- (iv) Decision of a chain-like nature can be systematically evaluated.
- (v) The decision tree concept is applicable in various problem areas, such as, introduction of a new product, make or buy problems, investment decisions, marketing strategy etc.

It may be noted that construction of decision trees is one of the various techniques available to the management for decision making but the results obtained from the tree models are not the final word and they do not constitute the decision itself. The tree model does not take into account the various qualitative factors into account : these should also be identified and evaluated before arriving at the optimal decision.

OPERATIONS RESEARCH

Operations research (also called operational research) has been defined in many ways. A simple definition is as follows :—

“Operations research is a scientific methodology which is applied to the study of the operations of large complex organisations or activities with a view to assessing the overall implications of various alternative courses of action, thus providing an improved basis for management decisions ”

The science of operations research was first applied in the last World War when scientists were asked to work in close collaboration with senior officers of the Royal Air Force, U.K., to find out the reasons for the ineffectiveness of certain radars supplied to the Air Force. These radars were technically sound and no apparent reason was available for their non-operation. The team applied careful scientific analysis backed by simple statistics and the results achieved were beyond expectation. Encouraged by these results, several operations research teams were set up to solve military problems arising in the various wings of the army.

Operations research scientists have now turned their attention to the complex problems of industry and business, and are applying scientific methods of observation and analysis to solve them. In a simple way, operations research

may be said to be the application of modern science to complex managerial problems so as to help the management in the scientific determination of policies and actions. Thus, operations research is primarily a tool for planning rather than for control. Engineers, technicians, mathematicians, statisticians and management accountants combine to form an operations research team which makes an overall scientific approach to problems through mathematical or statistical models. These models, which incorporate measurement of factors of chance and risk, constitute the framework of analysis ; they assist in predicting and comparing the results of feasible lines of action so as to assist in the choice of the best alternative.

The procedure followed by a scientist in tackling a problem is that to begin with, he makes an intelligent observation and analysis of the existing situation. Relevant facts and their inter-relationship are collected and the nature of the problem is studied with the help of these facts. In the next step, he formulates from the observations made, a hypothesis, theory, or model which expresses the relationship of the various factors in real-life situation. Thereafter, from the theory or model, he makes a prediction about what is likely to occur and lastly, he verifies from the actual facts whether the prediction proved to be correct. The operations research worker handles a problem in a similar manner. He collects statistics, prepares a model, makes prediction, i.e. outlines the results of a line of proposed action and then verifies the actual results to find out whether the decision was correct. Operations research actually determines what factors influence the state of affairs and tries to measure them, although most of these may be mere probabilities or the information may be incomplete. All these measurements are then incorporated into a generalised situation. It will thus be seen that like all sciences and research, operations research deals more in experiments and induction rather than in analysis and deductions. It is for this reason that operations research is said to be a "scientific method" and that is how the term "research" has been attached to it.

Perhaps the best way to understand what is operations research is to follow the method of its working. It has been stated above that operations research assists management in decision making. It would, however, be naive to think that operations research would consider very simple situations such as those where management have got full information or have a very limited choice or alternatives for decision making, or when they are fully aware of the results of a contemplated course of action. The executive concerned is quite capable of facing and solving such problems alone with the help of the simple tools of control and decision making available with him. Operations research is, therefore, concerned with situations where the following two types of difficulties arise :

- (i) *Numerous alternative courses of action are available and the management is fully aware of the consequence or result of each of them taken separately :* The difficulty in such a situation lies in seeking out that particular decision which would be the optimum, leading to maximization of profits and minimization of costs. Let us consider the example of a concern which manufactures a very large variety of products. The contribution of each of the products to profitability can be easily computed. Similarly, the demand on machine hours for the different processes, wastage at each stage of manufacture, marketing prospects, i.e.

the maximum and minimum sales at a given price, contractual quantity required for supply to customers and such other factors can easily be determined fairly accurately, for each of the products individually. But the real difficulty arises when the question to be faced is how to load the entire plant production so that every machine works to capacity, all bottlenecks are removed, the market requirements and restrictions are met, and in short, the total profit is maximised. Such problems are tackled through the technique of, what is known as *linear programming*. The inter-relationship of the large number of variable factors is determined through numerous mathematical equations and inequalities which when solved give the optimum solution.

- (ii) *The result of a course of action is not determinable and the management has to deal with probabilities and chances*: Here, in this situation, the operations research worker faces the problem by trying to assess the probability. This he does by using the statistical methods of probability theory. Situations where probabilities arise occur in all parts of the activities of an organisation. A common example is the problem of holding inventory when the supply as well as the demand are uncertain. In order to determine the optimum size of the inventory which should be held, operations research assesses the probabilities of supply and demand and matches them with the cost of holding the stock. Similar problems arise in the purchase of materials when future price of raw materials are obscure, or in respect of sales, when the effect of an advertising or sales campaign is uncertain. All such problems have been gone into by operations research workers who have established methods of probing into the uncertainties and of measuring chances so as to develop decision-making systems to the best advantage of the management.

Developing a Model. When a scientist deals with a problem, he studies the effect of a particular decision taken, through models. Thus while studying the planets, the astronomer builds up a model of the solar system or to take a more concrete example, when an engineer is asked to build a bridge, he builds a model of the bridge first. It is not a physical model but a diagram on paper showing what the bridge would be like when finally built. In short, models are representations of the real situations (things likely to happen) with the help of which scientists can carry out deductions.

In a similar way, the building of a model showing the structural relationship among the various factors occurring in real business situations forms the key point of operations research. A model may be in any form. Depending upon the requirements and complexity of the problem involved, an accounting system, a financial report, a diagram or a chart like the break-even chart may serve the purpose of a model. Three basic types of models in use are :

- (i) *Iconic models* : These models are mainly the scaled up or scaled down versions of the real thing they represent. For example, the model of a car or an aeroplane or a chemical model of a particular molecular structure are iconic models since they look what they represent except in size.

The main advantage of an iconic model is that because it visually resembles the thing it represents, there are practically no problems in translating the findings from the model into the real life situation. The disadvantage of such a model, however, is that it is difficult to manipulate for experimental purposes.

(ii) *Analogue models* : These models use one set of physical properties to represent another set. The best example is the analogue computer in which different quantities are represented by means of electrical and electronic relationships. Analogue models, though less obvious and less concrete than the iconic models, are more versatile and easier to manipulate.

(iii) *Mathematical or symbolic models* : Mathematical models use symbols and language of mathematics to represent variables and the relationship between them. As the name implies, these models are usually set in the form of mathematical expressions.

Mathematical models are more versatile and complex relationships may be easily modelled mathematically. The main limitations of these models are that it is difficult to relate them to reality and that a knowledge of mathematics is needed.

The *usefulness* of models is attributable to the following factors :

- (i) Building up a series of experiments of the real-life situation in order to forecast the consequences of various alternatives is time-taking and costly. By the time the result is known, the prevailing conditions might have changed to such an extent that the entire experimentation becomes fruitless. Models highlight real situations without going through actual experiments.
- (ii) There is not much scope for carrying out experiments on the basis of trial and error in real business situations involving complex issues. The result of an experiment undertaken on a wrong line may be disastrous. With models there is no such risk because in case of failure, the business will, after all, go bankrupt on paper only. Through the method of what is called simulation, models may be built up again and again to map out the real life situations under differing conditions so that the best line of action may be selected.
- (iii) Models are more accurate as they do away with abstract factors like guess work and intuition. With the assistance now available from electronic computers, models can incorporate a vast number of alternatives and restrictions and can be built in highly complex mathematical forms.

Classification of the Problems on Decision-making. Operations research is required to deal with a large number of decision-making problems in the industry. The contents of each of the problems have an individual peculiarity of their own, but it would be found that they can be grouped together into suitable forms or classifications in such a way that the problems in each group have similar characteristics. The field of study for the operations research worker is thus simplified and but for this classification, it would be a difficult task to study diverse problems arising in innumerable industries.

The classification of the problems may be broadly made under the heads mentioned below. In practice, it would be difficult to place a particular problem exactly in one or the other of the categories. The list may, therefore, be taken only as illustrative to help us in understanding the types of decision-making problems that operations research has to tackle.

(i) *Inventory problems.* A fruitful field of application of operations research is the situation where linking of irregular supply is made with irregular demand. Inventory is maintained in order to meet the demands of the customers and to keep production flowing. If the size of the inventory is cut down, it may mean production bottle-necks and delays, labour ineffectiveness, or loss of orders. On the other hand, large inventory locks up useful capital. The cost of keeping inventory is, therefore, to be matched against the cost of failure in production or loss of orders. A few inventory models were discussed in Chapter 2.

(ii) *Allocation.* Problems of allocation arise when a number of demands are made on the existing scarce resources and a decision is required to be taken as to how best to deploy the resources against the demands. Usually there are many different ways available of making the allocation of resources, the choice being made by reference to some objective which is in some way optimised. The problem is complicated by the fact that every division of the resources against a particular demand cannot be treated in isolation as there is an interaction between the several ways in which the resources can be divided. A simple example of a problem of allocation is provided in the case where a large number of customers are to be supplied with a variety of goods, stocked in a number of warehouses, and a decision is to be taken as to what goods and in what quantities are to be delivered to the various customers and from which warehouse, so as to minimise transport costs. The problem may be further complicated due to certain restraining factors. Some customers, for instance, may order for materials of varying qualities, or there might be some restrictions on the movement of goods on particular routes. While simple problems, where the relationships are linear, can be solved by linear programming, more complex mathematical techniques are required for those where the variable and constraining factors are very large and are not linear.

The linear programming techniques used for analysing allocation problems can be divided into three main groups according to the methods used for solution, viz. Simplex problem, Transportation problem and Assignment problem. These are discussed later in this chapter.

(iii) *Sequencing.* In sequencing problems, decision is required as to the order in which tasks should be performed. Production scheduling and vehicle routing problems are problems of sequencing. Solution to such problems is determined with the techniques of network analysis (PERT and CPM).

(iv) *Queuing and Waiting models.* Problems of queuing involve analysis of the demand for a service facility when the service time usually varies from customer to customer and where the arrivals for service are generally irregular, causing a queue for service from time to time. In such cases, the main difficulty is to properly match the demand with service facility; if the service facility is increased, the waiting time for the service will decrease and the demands can be met properly, but this would result in the service facility remaining idle at times, thus increasing costs. Providing transport to passengers waiting at bus stops,

prompt service to customers at a shop counter, effective loading or unloading of wagons or ships, and batches of items waiting to be processed at a machine centre, are familiar examples of queuing problems. The problems may be solved analytically by means of mathematical equations but in complex situations where there are series of queues and the arrivals and departures (or service) are random, the techniques of *simulation* are used.

(v) *Routing*. The best example of a problem of routing is the case of a fleet of transport supplying a large variety of products from a warehouse to a large number of customers, at various locations at varying distances from the warehouse. The problem is to decide how best the transport should be loaded and routed so as to minimize costs.

(vi) *Replacement and maintenance*. In the discussion of capital investment in a previous chapter, we had seen how action for the replacement of an asset is required to be taken when it is no longer economic to prolong its life. The determination of the particular time when an existing asset becomes uneconomic is a complicated one because a large number of variable factors such as running cost, repair cost, and depreciation are involved. The problem of replacement is confined not only to capital assets but it also covers the study of human skill or man-power replacement. Generally speaking, replacement problems arise because most physical devices are subject to deterioration in performance and/or random failure with the progress of time. Maintenance improves performance and reduces the chance of failure and if this maintenance takes the form of replacement, this can be done in a planned manner in advance or alternatively only when the failure takes place. Thus the objective of replacement model is to weigh the maintenance or replacement costs against the costs of breakdowns or failures so as to arrive at the minimum cost.

(vii) *Search*. These problems cover those efforts which have less chance of resulting in success. Research and development and problems of audit fall under this category.

(viii) *Competition and Game Theory*. Problems in this category include market study, sales promotion and selling. Competition problems are those where decisions have to be taken not with reference to situations arising due to natural causes, but in face of counter decisions taken by other parties which have a different objective.

We shall refer to some of the above techniques in detail, in later sections of this chapter.

Operations Research and the Cost Accountant. Operations research is a potent tool for planning and decision making. Many of the techniques and methods in use in operations research are not new. Accountants and managers have been using scientific and quantitative methods on a large scale. A qualified accountant has acquired knowledge about matters like scientific management, probability theory and other statistical methods and the use of different costs for different purposes, all of which have an operations research approach. Operations research, however, has a bias towards use of mathematical methods and it adopts statistical models as basis for analysis.

Like all other new techniques that have been developed in the recent years, operations research offers a challenge and an opportunity for the accountant.

Operations research is the work of a team of specialists and it is not expected that the accountant will take upon himself the entire responsibility for operations research. Nevertheless he should not lag behind and should always be on the alert to play his significant role as a member of the operations research team.

Operations research workers have to rely on the accountant for most of the basic data they use and the success of operations research would solely depend upon the accuracy of the information supplied. There should, therefore, be full co-operation between the operations research specialists and the accountant. The latter should hold a key position in the operations research team and should be made fully responsible for the figures emanating from his department.

LINEAR PROGRAMMING

When a business problem contains a number of constraints and interacting variable factors, the solution is to be found by determining the optimum plan, i.e. the best combination of these factors which would give the desired objectives of say, maximization of sales and/or profits, minimization of costs, reduction of idle time etc. Linear programming is the mathematical method used in such circumstances for selecting the optimum plans. Linear programming may be used for dealing with a variety of other problems such as determination of optimum product mix, sales mix, or material mix, optimum utilization of plants, men and other resources and best combination of resources and facilities.

Linear programming problems would consist of a number of inequalities and expressions which, if few in number, may be easily solved on the desk mathematically or even graphically. But in practice, the number of variable factors involved may be very large, necessitating the use of computers to arrive at the solution.

Linear programming approach should have the following basic characteristics :

- (i) Determination of the objective function which is usually maximization of profit or minimization of cost.
- (ii) Determination of basic relationship between the objective function and the demands on the available resources, specially if there are factors limiting or constraining the demands. Linear programming assumes that these relationships are linear and are, therefore, capable of being shown on a graph as straight lines. Another assumption is that all the factors and the relationships are certainties and not probables.
- (iii) Determination of alternatives or feasible solutions.
- (iv) Arriving at the optimum solution.

Linear programming problems which involve only two variables can be solved by developing a geometrical model. Three dimensional geometrical models can also be developed but their graphical solution is difficult. For problems that contain any number of variables, the standard method of simplex computation is used. When the number of variables is too large for manual computation, the simplex computation can be handled by a computer.

(a) *Graphical (or geometrical) solution*

Let us consider the following problem which is a typical linear programming problem of maximizing the objective.

A small scale company manufactures two products, T_1 and T_2 , each of which is processed in two shops, viz. Machining Shop, (M) and Finishing Shop, (F). One unit of T_1 requires 15 hours of machining and 24 hours of finishing time. The corresponding requirements for T_2 are 25 hours and 11 hours. The total available hours per day in the M and F Shops are 375 and 264 respectively. T_1 yields a profit of Rs. 18 per unit and T_2 , Rs. 16 per unit. How many units of T_1 and T_2 each, should be produced per day so as to maximize profit ?

If x_1 , x_2 represent units of T_1 , T_2 , the problem can be written in the matrix form as follows :—

(Variables)			
Product (x_1)		Product (x_2)	
Resource	Demand	Demand	Constraint
M	15	25	375
F	24	11	264
Profit	18	16	

The problem can also be written in the conventional linear programming form as :

Maximize $Z = 18x_1 + 16x_2$, (*objective function*),

Subject to :

$$15x_1 + 25x_2 \leq 375$$

$$24x_1 + 11x_2 \leq 264$$

$$x_1, x_2 \geq 0$$

Z denotes the profit and the expression, Maximize $Z = 18x_1 + 16x_2$, is called the objective function. The inequalities, $15x_1 + 25x_2 \leq 375$ and $24x_1 + 11x_2 \leq 264$, represent the constraint factors of labour time in M and F respectively. As production cannot be negative, the expressions $x_1, x_2 \geq 0$ express the non-negativity factor of x_1 and x_2 .

The inequalities given above may be represented geometrically as shown in the graph in Fig. 19.4. Because $x_1, x_2 \geq 0$, it follows that all values of x_1 and x_2 will be either zero or positive and so the feasible solutions will lie in the first quadrant only.

The constraint lines are drawn, as explained below :

If only T_1 and no T_2 is produced, the maximum number of units of T_1 which can be machined in M is $375/15 = 25$. If only T_2 and no T_1 is produced, the maximum units of T_2 machined in M are $375/25 = 15$. A line drawn between these two points outlines the constraint factor, $15x_1 + 25x_2 \leq 375$. In a linear programming problem, all constraint equations are represented by straight lines, and so only two points are necessary to plot the line. Since this is a "less than or equal to" constraint, any point lying on or below and to the left of this line will satisfy this inequality and the solution will lie somewhere in the region bounded by it. In the case of a "greater than or equal to" constraint, any point on the line or above and to the right of the equality line will satisfy the constraint. The line for the second constraint, $24x_1 + 11x_2 \leq 264$ is drawn in a similar manner. Thus the feasible solutions will lie in the dark shaded area bounded by the two straight lines, $15x_1 + 25x_2 = 375$ and $24x_1 + 11x_2 = 264$. (The constraint lines may be drawn more conveniently if the equations are rewritten in the

form, $\frac{x_1}{a} + \frac{x_2}{b} = 1$, i.e. as follows :

$$\frac{x_1}{25} + \frac{x_2}{15} = 1 ; \frac{x_1}{11} + \frac{x_2}{24} = 1$$

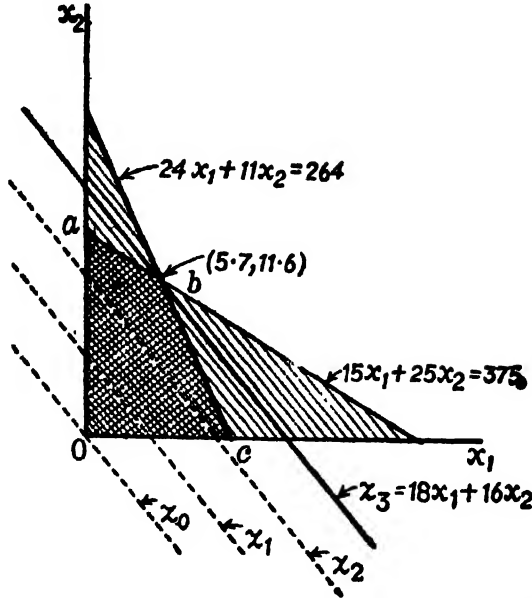


Fig. 19.4. Graphical solution of L.P. Problems (Maximisation)

The objective function, $18x_1 + 16x_2$, can be converted into an equation for a straight line by assigning any value for Z . Different values are assigned for Z and straight lines Z_0 , Z_1 , Z_2 and Z_3 , which are parallel lines having successive ascending values of Z , are drawn. Obviously Z_0 , Z_1 and Z_2 are not the maximum value because each of them can be moved up and still lie in the feasible region. The line Z_3 cannot be moved up any further as then it will be pushed out of the feasible region and so Z_3 is the maximum value of Z and the feasible solution which yields this maximum value is corner b of the feasible region. The co-ordinates of b , as read from the graph, are $(5.7, 11.6)$. Substituting these values of x_1 and x_2 in the objective function, the maximum profit is found to be

$$(5.7 \times 18) + (11.6 \times 16) = \text{Rs. } 288.2$$

This can be proved by solving the two equations : $24x_1 + 11x_2 = 264$ and $15x_1 + 25x_2 = 375$ and substituting the values of x_1 and x_2 in the objective function.

This can be proved further, thus :

We know that the solution lies at any one of the corners, 0, a, b, or c. (The theory relating to this has not been discussed in this text.) The profits at each of the points are as follows :—

	Point	Profit
0,	(0, 0)	0
a,	(0, 15)	$0 \times 18 + 15 \times 16 = \text{Rs. } 240$
b,	(5.7, 11.6)	$5.7 \times 18 + 11.6 \times 16 = \text{Rs. } 288.2$
c,	(11, 0)	$11 \times 18 + 0 \times 16 = \text{Rs. } 198$

The above problem envisages two constraints. The solution can be obtained in a similar manner for any number of constraints provided the lines drawn to represent each of the constraints do not make the graph too clumsy.

Let us now take another objective function, $Z=3x_1+5x_2$. From the graph in Fig 19.5, it will be seen that the line for this function coincides with the line for the equation, $15x_1+25x_2=375$. The solution to the revised problem is, therefore, not unique as any set of points lying on the line ab will satisfy all the constraints.

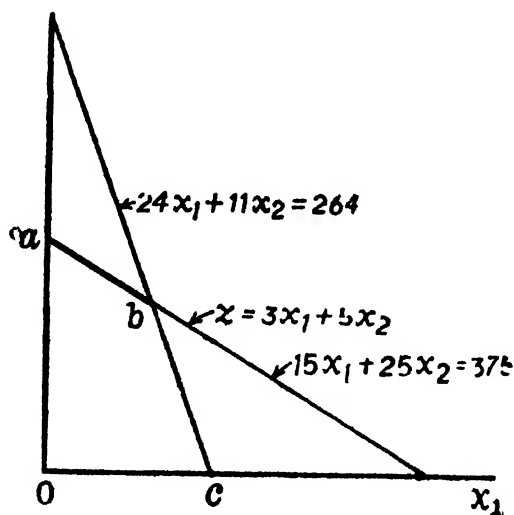


Fig. 19.5. Non-Unique Solution

There may be other situations such as when the lines representing the constraints diverge on the right hand side of the graph or are parallel to one another. In the former case, no polygon can be constructed and the solution is *unbounded*, while in the latter case, there does not exist any feasible solution. It may so happen that some of the constraint lines in a problem may fall outside the polygon. These indicate redundant relationships which do not take part in the solution and are automatically eliminated from the system.

Problems of minimization. Linear programming problems in which the objective function is to be *minimized*, e.g. when the objective is to minimize costs can also be solved graphically in a manner similar to the one adopted for the maximisation problem, provided only two variables are involved.

Let us consider the following problem of minimization :

$$\begin{array}{rcl}
 2x_1 + x_2 & \geq & 40 \\
 x_1 + x_2 & \leq & 40 \\
 14x_1 + 40x_2 & \geq & 560 \\
 x_1 & \geq & 24 \\
 x_1, x_2 & \geq & 0
 \end{array}$$

$$\text{Minimize } Z=27x_1+23x_2$$

The geometrical representation of the above problem has been shown in Fig. 19.6. It will be seen that the minimum value of Z is Z_0 and the minimum is at

the point b (16, 8) of the polygon, the value of which is, $(27 \times 16 + 23 \times 8) = 616$. It may be noted that in the inequalities $2x_1 + x_2 \geq 40$ and $14x_1 + 40x_2 \geq 560$, the constraint factors will always be not less than 40 and 560 respectively so that points lying on or above (but not below) the lines will satisfy these inequalities.

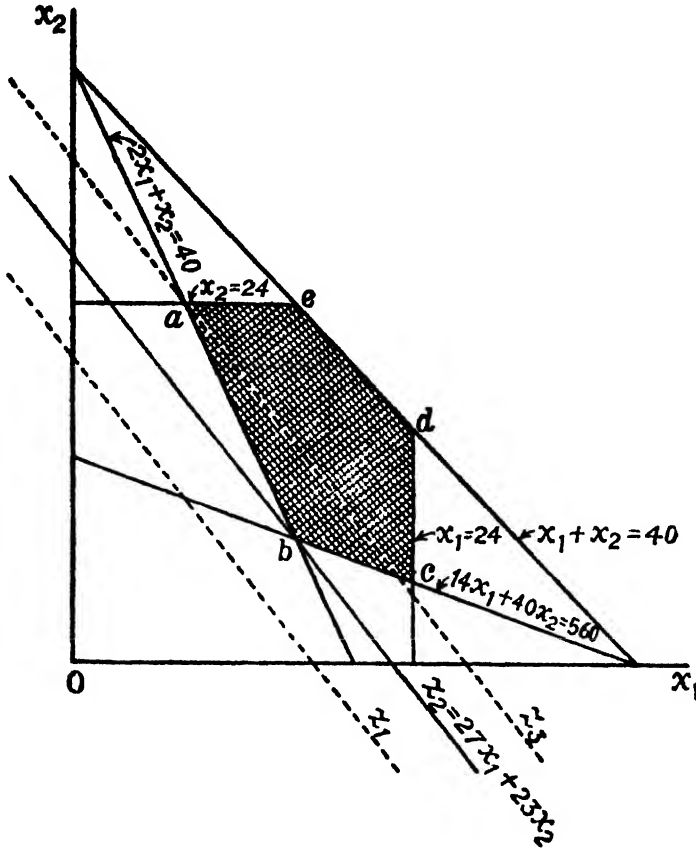


Fig. 19.6. Minimisation Problem

Shadow price. We have seen that the solutions to the above mentioned problems of linear programming provide the best choice, which may maximize profits or minimize costs under the existing constraints. If, however, the constraints are removed or relaxed to some extent, the profit would go up. The 'cost' of the constraint, commonly known as the *shadow price* of the constraint, is the additional profit that will be generated if one or more units of the constraints were relaxed. Thus, by showing the additional profit generated by relaxing a constraint, the shadow price sets an upper limit on the cost to acquire one more unit of a constraining factor. The shadow price can be shown graphically. For example, in the problem in Page 930, if the constraint of hours in the Machining Shop is relaxed and 75 more hours are made available, the constraint becomes $15x_1 + 25x_2 \leq 450$. The new constraint line has been drawn in the graph in Fig. 19.7. It will be seen that the optimum solution now moves to (3.8, 15.7) and the optimum profit is $3.8 \times 18 + 15.7 \times 16 = 319.6$ and the improvement in profit is 31.4 (i.e., $319.6 - 288.2$).

The shadow price of the constraint in M is Rs. 31.4 per 75 hours. This would mean that 75 more hours may be made available provided the cost of additional wages involved does not exceed Rs. 31.4. As obviously, skilled labour at such a low rate may not be available, the shadow price indicates that it is not worth while removing the constraint.

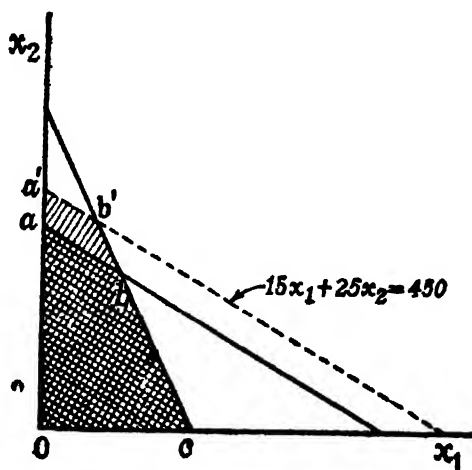


Fig. 19.7. Shadow Price

The shadow price of the other constraint may also be calculated in a similar manner.

(b) Simplex method

If there are numerous constraints and variables in a linear programming problem, the simplex method is used for arriving at the optimal solution. The method is an algebraic iterative procedure, moving step by step, from a given extreme point in the feasible solution area to the optimal extreme point. It will be seen that the graphical method, discussed earlier, is also a similar iterative process and in fact, no procedure has yet been found which will solve a linear programming problem in one single step or through set formulae. Simplex method is nowadays the most widely used method for solving linear programming problems.

The theory of the simplex method will not be considered in this text. We discuss the tableau format for computation which is helpful when the calculations are to be made manually. Let us consider the following problem :

EXAMPLE 19.3.

A manufacturing firm has discontinued production of a certain unprofitable line, and this has created considerable excess production capacity. Management is considering to devote this excess capacity to produce one or more of the three products, 1, 2 and 3. The available excess capacity on the machines which might limit output, is summarised in the following table :

Machine Types	Available excess capacity (in machine hours per week)
Milling machine	250
Lathe	150
Grinder	50

The number of machine hours required for each unit of the respective products is given below :

Machine Type	Capacity Requirement (in machine hours per unit)		
	Product 1	Product 2	Product 3
Milling machine	8	2	3
Lathe	4	3	0
Grinder	2	0	1

The per unit contribution would be Rs. 20, Rs. 6 and Rs. 8 respectively for products 1, 2 and 3.

- Formulate the problem mathematically ;
- How much of each of the three products the firm should produce and sell in order to maximise the contribution ?
- Determine the maximum contribution.

(I. C. W. A., Final)

ANSWER :

(In solving the problem, elaborate discussion has been made at each stage, in order to explain the application of simplex method.)

If each unit of products 1, 2 and 3 is denoted by x_1 , x_2 and x_3 respectively, the problem can be put in the following mathematical form :

Maximise contribution, $Z = 20x_1 + 6x_2 + 8x_3$

Subject to the constraints

$$8x_1 + 2x_2 + 3x_3 \leq 250$$

$$4x_1 + 3x_2 \leq 150$$

$$2x_1 + x_3 \leq 50$$

$$x_1, x_2, x_3 \geq 0 \text{ (i.e. } x_1, x_2, x_3 \text{ are all positive)}$$

The first step in solving the problem by simplex method is to convert the inequalities into equalities. Taking the first inequality, $8x_1 + 2x_2 + 3x_3 \leq 250$, we find that there may be two possible situations, viz. $8x_1 + 2x_2 + 3x_3$ is either equal to 250 or less than 250. In the latter case, the left and right hand sides of the inequality can be balanced if we add another non-negative variable, say S_1 on the left hand side, Thus,

$$8x_1 + 2x_2 + 3x_3 + S_1 = 250 ; \text{ where } 0 \leq S_1 \leq 250$$

The added variable is known as slack variable and here, it represents the hours unutilised. As we shall see later, in an equality having a greater than or equal to (\geq) sign, the variable, called the surplus variable, would be deducted. This would represent the hours not available. Since the hours not utilised or not available would not be worked, these slack or surplus variables have 0 contribution.

In a similar manner if we add two other non-negative variables S_2 and S_3 one each to the other inequalities, the system is converted into equations as follows :

Maximise $Z = 20x_1 + 6x_2 + 8x_3 + 0S_1 + 0S_2 + 0S_3$

Subject to :

$$8x_1 + 2x_2 + 3x_3 + S_1 = 250$$

$$4x_1 + 3x_2 + S_2 = 150$$

$$2x_1 + x_3 + S_3 = 50$$

Converting the inequalities into equalities by adding slack variables makes the solution of the problem easier. At the same time, it does not affect the optimum solution so long as the slack variables are given zero coefficient in the objective function. This would mean that all the slack variables have zero contribution. Since no manager would like to waste resources on a zero

contribution production, he will ignore the slack variable even if the optimum solution gives some value for it and this value will merely indicate the quantity of the resources not being utilized.

[For $\sum a_{ij}x_j \leq b_i$, slack variable represents the waste involved in the particular phase of the system modelled by the constraint, say, hours available but not used.

For $\sum a_{ij}x_j \geq b_i$, surplus variable represents excess input into the particular phase of the system modelled by the constraint; say, surplus production over and above needed to meet a contract. While slack variables are added to the left hand side of the equation, surplus variables are deducted from the left hand side.

Artificial variable is added to the left hand side in each equation that does not contain a slack variable. Thus each equation will have either a slack variable or an artificial variable. It may be noted that although slack and surplus variables do not alter the nature of the constraint and objective, an artificial variable does represent severe penalty incurred for making a unit assignment to the constraint.

Artificial variables are incorporated in the objective function with a large positive coefficient for a minimisation programme or a very large negative coefficient in a maximisation programme, with the symbols $\pm M$. Thus M represents severe penalty incurred for making a unit assignment to the constraint variable. In solving problems manually, the penalty costs may be left as $\pm M$; in computer programming, M is usually assigned three or four times the magnitude of any other largest figure in the programme.]

The next step is to write the initial (i.e. the first) tableau in the matrix form to give the feasible solution, as shown in Fig. 19.8. First, all the variables including the slack variables are marked on the top row (called the variable row) of the tableau. Next, the coefficients of the variables in each equation are noted in each variable column. As each of the slack variables appears in only one equation, the coefficient of each of these variables is 1 in one equation and 0 in the rest. The matrix of the slack variables is thus an identity, i.e. a square matrix with a diagonal of plus ones, and all the other elements zero.

There are three more columns in the matrix, viz. x_b on the extreme right and x_i and c_i on the left hand side. In column x_b (designated the constant column or current solution column), the constants (i.e. values) of each equation are inserted. The significance of columns x_i and c_i is explained later.

x_i	c_i	x_1	x_2	x_3	S_1	S_2	S_3	x_b
S_1	0	8	2	3	1	0	0	250
S_2	0	4	3	0	0	1	0	150
S_3	0	2	0	1	0	0	1	50
C_j		20	6	8	0	0	0	
Feasible Solution		0	0	0	250	150	50	$(Z = 250 \times 0 + 150 \times 0 + 50 \times 0 = 0)$
Z_j		0	0	0	0	0	0	
$C_j - Z_j$		20	6	8	0	0	0	
		↑			(250/8 = 31.25)	(150/4 = 37.50)	↓ (50/2 = 25)	
		Entering Variable			Departing variable			

Fig. 19.8. First Tableau

The objective row, C_j is inserted next, i.e. the coefficients of the variables in the objective function are placed in the appropriate columns of the tableau. This row indicates the net contribution from each of the variables and remains unchanged in all the iterations. As the objective function for the simplex must contain all the variables including the slack variables, we may write this function as $20x_1 + 6x_2 + 8x_3 + 0S_1 + 0S_2 + 0S_3$, by assigning zero as the coefficient of each of the slack variables S_1 , S_2 and S_3 . This does not change the value of the operation.

[The fundamental theorem in the simplex method states that if there are k variables and m inequities (or m converted equations), the set of variables which will maximise the objective function must possess k elements which are zero. The procedure for finding a feasible solution is to choose k of the $(k + m)$ points and assign them zero value. The equations are then solved for the remaining m points. The feasible solution is then tested for optimality (as per the method described later) and if it is found to be non-optimal, another set of k points are chosen and a different feasible solution with improved Z_j worked out. Eventually, by proceeding in steps from one feasible solution to another, the optimal solution is arrived at.]

Reverting to the problem, the feasible solution is read off by selecting the zero variables, i.e. the variables other than those whose columns contain one 1 and the rest zeros. Thus we set x_1 , x_2 and x_3 at zero (i.e. all variables except the identity are set to zero), so that $s_1 = 250$, $s_2 = 150$ and $s_3 = 50$. The non-zero variables, S_1 , S_2 and S_3 are now placed in column x_i (which denotes the basic variables in the solution) and their corresponding values, i.e. their coefficients in Z representing the gross contribution of each (here, zero in each case), are placed in the objective column c_j . With the non-zero or slack variables having the foregoing values, x_1 , x_2 and x_3 must all be equal to zero.

The next step is to complete the row Z_j , each element of which is $\sum_{i=1}^m c_i x_{ij}$. Here $m = 3$ and all the values of Z_j are equal to zero because c_i is zero in each case. The final step in the completion of the first feasible solution tableau is to place the row $C_j - Z_j$ which is called the index row. This row indicates the net contribution from each variable.

The feasible solution is now tested for optimality in the following manner. The solution arrived at is obviously not the optimum solution since x_1 , x_2 and $x_3 = 0$ and the profit is also $= 0$. The general rule for a tableau to represent an optimal solution is that with the exception of column x_0 , no value of $C_j - Z_j$ in any column of the index row should be positive. (If the values of $Z_j - C_j$ in the index row are taken, the test for optimality would be that there should be no negative values in any column of the index row.) If none of the values are positive but if any are zero, it shows that the solution is not unique and other optimal solutions exist with the same value of Z . Here, the columns x_1 , x_2 and x_3 contain positive values in the index row which shows that the optimal solution has not been arrived at and so, we have to proceed to the next step of improving the solution.

We have now to choose another set of variables and assign zero value to each. In short, the procedure will be to make one of the zero value variables of the first stage as non-zero; this is called the entering variable. To compensate, one of the non-zero variables becomes zero in the process; this is called the departing variable. For selecting the entering and departing variables, we have

first to determine the key or pivot column and the key or pivot row. The pivot column indicates the entering variable and the pivot row the departing variable ; at the intersection of the two, lies the pivot number or key element. A basic method to arrive at the optimum in the least number of steps is to select the pivot column as the one that contains the highest positive value in the index row, meaning thereby the variable which gives the highest net contribution. Here, column x_1 having 20 in the index row, is the pivot column and the entering variable is x_1 . In general, the entering variable should have the following properties :—

- (i) It should be zero in the present tableau ;
- (ii) $C_j - Z_j$ should be 0 ; and
- (iii) At least one of the elements in the column for the entering variable must be greater than zero.

If two or more columns have the same highest positive value, i.e. the same net contribution, any one of these may be selected as the pivot column. It should, however, be tested whether the selection of any one particular column improves Z ; if not, another column having the same positive value should be chosen.

Now to determine the pivot row and the departing variable, each of the current values (x_0) is divided by the corresponding values in the pivot column and the row with the lowest quotient is selected as the pivot row ; thus,

x_1 (Basic variable)	x_0 (Current value)	x_1 (Pivot column value)	$x_0 \div x_1$ (Quotient)
S_1	250	8	31.25
S_2	150	4	37.50
S_3	50	2	25 (Minimum)

The above table indicates the limitation that the available machine hours allow only 31.25, 37.50 and 25 units of (Product 1) to be processed through Milling Machine, Lathe and Grinder respectively but out of these, only 25 units (the smallest of the limits) of x_1 can be completely manufactured using up all the available capacity of the Grinder.

Thus row S_3 is the pivot row and variable x_1 is the departing variable which is to become zero in the next iteration.

Preparation of the second iteration tableau is now taken up. First, the variable and objective columns, x_1 and c_1 are set up. These columns are copied from the previous iteration, except for the pivot row, and the items from the pivot row are replaced by those from the pivot column. Thus S_3 and 0 go out and x_1 and 20 (i.e. its objective row value) come in.

The next operation is to calculate the new coefficient matrix by suitable row operations in such a manner that the key element becomes 1 and elements of the pivot column are each zero. The new iteration values to be placed in each column of the pivot row is the quotient of the value in the pivot row divided by the pivot number (in this case, 2). It is obvious that by this process, we always obtain 1 as the replacement of the key element.

	x_0	x_1	x_2	x_3	S_1	S_2	S_3
Pivot row values	50	2	0	1	0	0	1
New iteration values	25	1	0	$\frac{1}{2}$	0	0	$\frac{1}{2}$

Computation of the iteration values in a row, other than the pivot row, is

made by subtracting appropriate multiple or sub-multiple values of the row elements from the corresponding values in the new iteration in the pivot row. The multiples and sub-multiples are calculated in such a way as to obtain zero in the row position in the pivot column.

The index row, $C_j - Z_j$ and the second tableau are formed, as shown in Fig. 19.9. There is no change in the row C_j . As already explained earlier, the values in row Z_j are obtained by summing the products of each column element with the corresponding values of C_j . Thus,

for column x_0 , $Z = 50 \times 0 + 50 \times 0 + 25 \times 20 = 500$

$$x_1, Z = 0 \times 0 + 0 \times 0 + 1 \times 20 = 20$$

$$x_2, Z = 2 \times 0 + 3 \times 0 + 0 \times 20 = 0$$

$$x_3, Z = -1 \times 0 + (-2) \times 0 + \frac{1}{2} \times 20 = 10$$

$$S_1, Z = 1 \times 0 + 0 \times 0 + 0 \times 20 = 0$$

$$S_2, Z = 0 \times 0 + 1 \times 0 + 0 \times 20 = 0$$

$$S_3, Z = -4 \times 0 + (-2) \times 0 + \frac{1}{2} \times 20 = 10$$

x_j	C_j	x_1	x_2	x_3	S_1	S_2	S_3	x_0
S_1	0	0	2	-1	1	0	-4	50
S_2	0	0	3	-2	0	1	-2	50
x_1	20	1	0	$\frac{1}{2}$	0	0	$\frac{1}{2}$	25
C_j		20	6	8	0	0	0	
Z_j		20	0	10	0	0	10	500
$C_j - Z_j$		0	6 \uparrow	-2	0	0 \downarrow	-10	

Fig. 19.9. Second Tableau

Since the index row, $C_j - Z_j$ in the second tableau still contains a positive value, optimum solution has not been reached and so further improvement in the solution can be made. The process of iteration is, therefore, continued and in a similar manner the third tableau (Fig. 19.10) is set up. Since this tableau also contains a positive value in the index row, the process is continued to form the fourth tableau (Fig. 19.10).

x_j	C_j	x_1	x_2	x_3	S_1	S_2	S_3	x_0
S_1	0	0	0	1/2	1	-1/3	-1/3	2/3
x_2	6	0	1	-1/3	0	1/3	-1/3	2/3
x_1	20	1	0	$\frac{1}{2}$	0	0	$\frac{1}{2}$	25
C_j		20	6	8	0	0	0	
Z_j		20	6	6	0	2	6	600
$C_j - Z_j$		0	0	2 \uparrow	0 \downarrow	-2	-6	

x_j	C_j	x_1	x_2	x_3	S_1	S_2	S_3	x_0
x_3	8	0	0	1	3	-2	-8	50
x_2	6	0	1	0	2	-1/2	-6	50
x_1	20	1	0	0	-1/2	1	1/2	0
C_j		20	6	8	0	0	0	
Z_j		20	6	8	6	2	0	700
$C_j - Z_j$		0	0	0	-6	-2	0	

Fig. 19.10. Third and Fourth Tableau—Optimum Solution

Since the index row, $C_j - Z_j$ in the fourth iteration does not contain any positive value, the optimum solution has now been reached. (The process of iteration would have been continued otherwise.) Interpretations of the final tableau are as follows :

1. The optimum product mix consists of 50 units of Product 3 and 50 units of Product 2. There is no production of Product 1 since this would yield zero profit.
2. The optimum profit is Rs. 700.
3. The values in the column x_0 against the slack variables indicate the under-utilised capacities. Here there is no under-utilised capacity.
4. The shadow costs of x_1 and x_2 are 6 and 2 respectively.

The following examples will further illustrate the simplex method and the interpretation of the final solution :

EXAMPLE 19.4.

- (a) The following details are taken from the forecasts for 1979 of XYZ Limited.

Sales demand :	Thousands of units per annum, maximum
Super de luxe model (x_1)	500
De luxe model (x_2)	750
Export model (x_3)	400

Production :

Two production facilities are required, machining and assembly, and these are common to each model.

Capacity in each facility is limited by the number of direct labour hours available.

	Direct labour, total hours available (in millions)	Direct labour hours, per unit for each model		
		x_1	x_2	x_3
Machining	1.4	0.5	0.5	1.0
Assembly	1.2	0.5	0.5	2.0

Contribution, estimated to be :	Amount per thousand units in £
Model	
x_1	1,500
x_2	1,300
x_3	2,500

You are required, using the above information, to set up the first tableau of a linear programme to determine the product mix which will maximise total contribution and then to complete the first iteration only.

- (b) Interpret the following tableau, given that it is the final solution to the above problem. The s variables (s_1, s_2, s_3, s_4, s_5) relate to the constraints in the same sequence as presented in (a) above.

x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	b_j
1	0	0	1	0	0	0	0	500
0	0	0	0.25	0.25	1	0	-0.5	112.5
0	0	1	-0.25	-0.25	0	0	0.5	287.5
0	0	0	-0.25	-0.25	0	1	-0.5	487.5
0	1	0	0	1	0	0	0	750
0	0	0	-875	-675	0	0	-1,250	-2,443,750

ANSWER :

(a) The problem is :

$$\text{Maximise } Z = 1,500x_1 + 1,300x_2 + 2,500x_3$$

Subject to the restraints ;

$$x_1 \leq 500$$

$$x_2 \leq 750$$

$$x_3 \leq 400$$

$$0.5x_1 + 0.5x_2 + x_3 \leq 1,400$$

$$0.5x_1 + 0.5x_2 + 2x_3 \leq 1,200$$

(in thousands of units)

The initial simplex tableau is :

x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	x_0
1	0	0	1	0	0	0	0	500
0	1	0	0	1	0	0	0	750
0	0	1(KE)	0	0	1	0	0	400
0.5	0.5	1	0	0	0	1	0	1,400
0.5	0.5	2	0	0	0	0	1	1,200
-1,500	-1,300	-2,500	0	0	0	0	0	0

Where s_1, s_2, s_3, s_4, s_5 are the slack variables introduced into the 5 constraints.

The second tableau is produced as follows :

x_1	x_2	x_3	s_1	s_2	s_3	s_4	s_5	x_0
1	0	0	1	0	0	0	0	500
0	1	0	0	1	0	0	0	750
0	0	1	0	0	1	0	0	400
0.5	0.5	0	0	0	-1	1	0	1,000
0.5	0.5	0	0	0	-2	0	1	400
-1,500	-1,300	0	0	0	-2,500	0	0	1,000,000

(b) The interpretations are as follows :

(i) The solution to the problem is

$$x_1 = 500,000, x_2 = 750,000 \text{ and } x_3 = 287,500$$

$$\text{Contribution} = \text{£ } 2,443,750$$

(ii) The slack variables assume the following values :

$$S_1 = 0, S_2 = 0, S_3 = 112.5, S_4 = 487.5 \text{ and } S_5 = 0$$

This implies that :

the production of the export model (x_3) is 112,500 units short of the maximum demand, and

there are 487,500 hours of machining time not utilised.

(iii) The shadow prices associated with the first constraint (demand for x_1 , Super deluxe model), the second constraint (demand for x_2 , De luxe model,) and the fifth constraint (Assembly production capacity) are 875,675 and 1,250 respectively. This implies that :

(a) If the maximum demand for the super deluxe model could be increased by 1,000 units, an additional contribution of £ 875 could be obtained ;

(b) If the maximum demand for the deluxe model could be increased by 1,000 units, an additional contribution of £ 675 could be obtained ;

(c) If an additional 1,000 hours of assembly time could be provided, an additional contribution of £ 1,250 could be obtained.

EXAMPLE 19.5.

A company possesses two manufacturing plants, each of which can produce three products, x, y, z from a common raw material. However, the proportions in which the products are different in each plant and so are the plants operating costs per hour. Data on production per hour and costs are given below, together with current orders in hand for each product.

	Product			Operating cost per hour
	x	y	z	Rs.
Plant A	2	4	3	9
Plant B	4	3	2	10
Orders on hand	50	24	60	

You are required to use the simplex method to find the number of production hours needed to fulfill the orders on hand at minimum costs. (I. C. W. A., Final)

ANSWER :

If x_1 and x_2 be the number of operating hours used in Plant A and Plant B respectively, the problem will be formulated as follows :—

Minimise cost, $Z = 9x_1 + 10x_2$, subject to,

$$2x_1 + 4x_2 \geq 50 \text{ (or } x_1 + 2x_2 \geq 25)$$

$$4x_1 + 3x_2 \geq 24$$

$$3x_1 + 2x_2 \geq 60$$

$$x_1, x_2 \geq 0$$

Introducing surplus variables, s_1 , s_2 , and s_3 and artificial variables, A_1 , A_2 and A_3 , the equations will be,

Minimise $Z = 9x_1 + 10x_2 + 0s_1 + 0s_2 + 0s_3 + MA_1 + MA_2 + MA_3$, subject to :

$$x_1 + 2x_2 + A_1 - s_1 = 25$$

$$4x_1 + 3x_2 + A_2 - s_2 = 24$$

$$3x_1 + 2x_2 + A_3 - s_3 = 60$$

The Simplex Tableau will be

x_i	c_j	x_1	x_2	S_1	S_2	S_3	A_1	A_2	A_3	x_b
A_1	M	1	2	-1	0	0	0	0	0	25 [25/1=25]
A_2	M	4	3	0	-1	0	0	1	0	24 [24/4=6]
A_3	M	3	2	0	0	-1	0	0	1	60 [60/3=20]
C_j		9	10	0	0	0	M	M	M	
Z_j		8M	7M	-M	-M	-M	M	M	M	109M
$C_j - Z_j$		9-8M	10-7M	M	M	M	0	0	0	
The subsequent tableau will be :										
x_i	c_j	x_1	x_2	S_1	S_2	S_3	A_1	A_2	A_3	x_b
A_1	M	0	$\frac{1}{2}$	-1	$\frac{1}{2}$	0	1	$-\frac{1}{2}$	0	19 $19/\frac{1}{2}=76$
x_1	9	1	$\frac{1}{2}$	0	$-\frac{1}{2}$	0	0	$\frac{1}{2}$	0	6
A_3	M	0	$-\frac{1}{2}$	0	$\frac{3}{2}$	-1	0	$-\frac{1}{2}$	1	42 $42/\frac{1}{2}=84$
C_j		9	10	0	0	0	M	M	M	
Z_j		9	$M+\frac{9}{2}$	-M	$M-\frac{1}{2}$	-M	M	$-M+\frac{1}{2}$	M	
$C_j - Z_j$		0	$\frac{1}{2}-M$	M	$\frac{1}{2}-M+\frac{1}{2}$	M	0	$2M-\frac{1}{2}$	0	
A_1	M	0	$\frac{1}{2}$	-1	0	$\frac{1}{2}$	1	0	$-\frac{1}{2}$	5 $5/\frac{1}{2}=10$
x_1	9	1	$\frac{1}{2}$	0	0	$-\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{1}{2}$	20 $20/\frac{1}{2}=40$
S_2	0	0	$-\frac{1}{2}$	0	1	$-\frac{1}{2}$	0	-1	$\frac{1}{2}$	56
C_j		9	10	0	0	0	M	M	M	
Z_j		9	$\frac{1}{2}M+6$	-M	0	$\frac{1}{2}M$	M	0	$-\frac{1}{2}M+3$	$5M+180$
$C_j - Z_j$		0	$-\frac{1}{2}M+4$	M	0	$-\frac{1}{2}M$	0	M	$\frac{1}{2}M-3$	
x_1	10	0	1	$-\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{1}{2}$	0	$-\frac{1}{2}$	$\frac{1}{2}$
x_2	9	1	0	$\frac{1}{2}$	0	$-\frac{1}{2}$	$-\frac{1}{2}$	0	$\frac{1}{2}$	$\frac{2}{3}$
S_2	0	0	0	$-\frac{1}{2}$	1	$-\frac{1}{2}$	$-\frac{1}{2}$		$\frac{1}{2}$	$\frac{20}{3}$
C_j		9	10	0	0	0	M	M	M	
Z_j		9	10	-3	0	-2	3	0	2	195
$C_j - Z_j$		0	0	3	0	2	$M-3$	M	M	

Since $C_j - Z_j$ in columns are positive, the optimal solution is now reached, as follows :

Plant A	35/2 hours
Plant B	15/4 hours
Minimum cost Rs. 195	

The solution shows further that Plant B has a surplus capacity of 229/4 hours and that the costs of products x and y are 3 and 2 respectively per hour.

In solving certain problems by the simplex method, it is found that at a stage, the iteration arrived at is the same as one of the earlier iterations. No solution is possible for such problems and this phenomenon is known as *cycling*. Cycling is a characteristic of *degeneracy* which is discussed later in this chapter.

Basically, the simplex method is a maximising technique but this can also be used for solving problems of minimisation. For this purpose, if the objective function, Z is to be minimized, it would be regarded as merely a problem of maximising $(-Z)$.

The simplex routine cannot start if some of the constant terms are negative because in such a case, the solution will contain a negative co-ordinate and thus will not be feasible. To solve the problem, we have to find a feasible solution somehow. Generally, an artificial positive variable, which is not greater than the slack variable, is introduced. For example, if the given restrictions are :

$$\begin{aligned} x_1 + x_2 + x_3 &\leq 6 \\ -2x_1 - x_2 + x_3 &\leq -4 \end{aligned}$$

Introducing the slack variables, x_4 and x_5 , the restrictions become,

$$\begin{aligned} x_1 + x_2 + x_3 + x_4 &= 6 \\ -2x_1 - x_2 + x_3 + x_5 &= -4 \end{aligned}$$

The solution would be (0, 0, 0, 6, -4), i.e. a non-feasible solution. An artificial variable x_6 , which is positive but not greater than x_5 , is introduced. The restrictions now will be,

$$\begin{aligned} x_1 + x_2 + x_3 + x_4 &= 6 \\ -2x_1 - x_2 + x_3 + x_5 - x_6 &= -4 \end{aligned}$$

or

$$\begin{aligned} x_1 + x_2 + x_3 + x_4 &= 6 \\ 2x_1 + x_2 - x_3 - x_5 + x_6 &= 4 \end{aligned}$$

The first tableau will be written as follows :

x_j	x_1	x_2	x_3	x_4	x_5	x_6	x_0
x_1	1	1	1	1	0	0	6
x_5	2	1	-1	0	-1	1	-4

The artificial variable x_6 is selected as the departing variable and the entering variable is chosen carefully to be one of the original variables, x_1 , x_2 , or x_3 so that the choice yields a transformed matrix with a non-negative column. Here, x_2 is selected as the entering variable and the next tableau becomes :

x_j	x_1	x_2	x_3	x_4	x_5	x_6	x_0
x_1	1	0	-2	-1	-1	1	2
x_5	2	1	-1	0	-1	1	4
Solution	0	4	0	2	0	0	

This solution is feasible and the usual simplex routine may be continued to find the optimum solution.

Dual Problem. The simplex problems that we have dealt with so far are those of a class known as the primal problem. The primal problem is the outcome of the primary relationship normally observed when the basic facts presented are analysed. For every primal problem there is a related dual problem. The dual problem may be set up either from the primal or directly from the original data from which the primal was set. We have seen that a maximisation problem can be converted into a minimisation problem by changing the rows and columns matrix. If the primal problem is of maximisation, the converted minimisation problem would be the dual problem. Similarly if the minimisation problem is considered to be the primal, the converted maximisation problem would be the dual problem.

The optimal solution to the dual problem is identical to that of the primal problem so far as the evaluation of the objective function is concerned. The number of constraints and variables in the dual problem are different from that in the primal. Hence if the primal problem consists of large number of constraints and variables, it will be easier and hence desirable to solve its dual problem.

The dual problem is illustrated in the example given below :

EXAMPLE 19.6.

A diet conscious housewife wishes to ensure certain minimum intake of vitamins A, B and C for the family. The minimum daily (quantity) needs of the vitamins A, B and C for the family are respectively 30, 20 and 16 units. For the supply of these minimum vitamin requirements, the housewife relies on two fresh foods. The first one provides 7, 5 and 2 units of the three vitamins per gram respectively and the second one provides 2, 4 and 8 units of the same three vitamins per gram of the foodstuff respectively. The first food costs Rs. 3 per gram and the second Rs. 2 per gram. The problem is how many grams of each foodstuff should the housewife buy every day to keep her food bill as low as possible.

- (i) Formulate the underlying L.P. problem.
- (ii) Write the 'Dual' problem.
- (iii) Solve the 'Dual' problem by using the simplex method.
- (iv) Solve the primal problem graphically.
- (v) Interpret the dual problem and its solution.

(I.C.W.A., Final)

ANSWER :

- (i) The primal problem is to minimise the cost function ;

If F_1 and F_2 denote one unit of each of the foods,

Objective : Minimise $C = 3F_1 + 2F_2$;

Subject to,

$$7F_1 + 2F_2 \geq 30$$

$$5F_1 + 4F_2 \geq 20$$

$$2F_1 + 8F_2 \geq 16$$

$$F_1 \geq 0, F_2 \geq 0$$

- (ii) The dual problem will be the maximising function ;

If x_1 , x_2 and x_3 denote one unit of vitamins A, B and C respectively,

Objective : Maximise $Z = 30x_1 + 20x_2 + 16x_3$

Subject to,

$$7x_1 + 5x_2 + 2x_3 \leq 3$$

$$2x_1 + 4x_2 + 8x_3 \leq 2$$

$$x_1, x_2, x_3 \geq 0$$

(The changes made in converting the primal to dual problem are as follows :—

1. The minimising (maximising) objective function of the primal is changed into maximising (minimising) function. In the given problem, the objective function of the primal is to minimise cost, whereas in the dual, the objective is to maximise the profit (here, the vitamin intake).

2. For each constraint in the primal, a dual variable is defined. For F_1 and F_2 in the problem, the dual variables are x_1 and x_2 .

3. The right hand side constants of the primal (30, 20 and 16) are the coefficients of the objective function of the dual.

4. The constraints of the dual are formed by transposing the coefficients of the primal (7, 5 and 2 and 2, 4 and 8) and the right hand side values of the dual are the coefficients of the objective function of the primal (3 and 2).

5. The signs of the constraint \geq (or \leq) of the primal are reversed to \leq (or \geq) in the dual.)

(iii) The initial tableau for solving the dual problem by the simplex method will be as follows :—

x_i	c_i	x_1	x_2	x_3	s_1	s_2	x_0
s_1	0	7	5	2	1	0	3
s_2	0	2	4	8	0	1	2
C_j		30	20	16	0	0	
Z_j		0	0	0	0	0	
$Z_j - C_j$		-30	-20	-16	0	0	

The second and third tableau will be :

x_i	c_i	x_1	x_2	x_3	s_1	s_2	x_0
x_1	30	1	5/7	2/7	1/7	0	3/7
s_1	0	0	18/7	52/7	-2/7	1	8/7
C_j		30	20	16	0	0	
Z_j		30	150/7	60/7	30/7	0	90/7
$Z_j - C_j$		0	10/7	-52/7	30/7	0	
x_1	30	1	8/13	0	2/13	-1/26	20/52
x_2	16	0	9/26	1	1/26	7/52	8/52
C_j		30	20	16	0	0	
Z_j		30	24	16	4	1	14
$Z_j - C_j$		0	4	0	4	1	

Since there are no negative values for $Z_j - C_j$ in the last tableau, this gives the optimum solution, which is Rs. 14 as the maximum cost.

(iv) The graphical solution to the primal problem is left as an exercise for the student. It will be seen that the solution is $F_1 = 4$ and $F_2 = 1$ and the minimum cost is Rs. 14, i.e. the same as the one for the dual problem.

(v) The primal problem can also be solved by the simplex method. It will be seen that there will be three slack variables and three artificial variables in the initial tableau so that the final solution will be arrived at by a lengthy process of several iterations. The dual problem which involves only two slack variables, needs only a few steps to arrive at the optimum solution.

TRANSPORTATION (OR DISTRIBUTION) PROBLEM

As stated before, transportation problems are allocation problems which constitute a sub-class of linear programming problems. These are also called Distribution problems. A typical transportation problem is described in the next page.

Specified units of a uniform product are available at each of a number of different origins (e.g. factories). There are a number of different destinations (e.g. warehouses) to each of which specific units of the product are required to be sent. The cost of transportation of one unit from any one origin to any one destination is known. Assuming that it is possible to transport from any one origin to any one destination, the problem is to minimize the cost of routing from the origins to the destinations.

One of the characteristics of transportation problems is that all the units transported are alike. The values of the total demand (destinations) and the total supply (origins) may or may not be equal. In the latter case, a special treatment is necessary and the problem is solved by introducing, what are known as 'dummies'. These will be discussed later.

Transportation problems apply not only to problems of transportation and distribution but they cover other areas and problems relating to allocation of limited resources. Assignment problems constitute a special type of transportation problem.

Expressing mathematically, the transport problem has m origins with origin i possessing a_i items and n destinations (n may not be equal to m) requiring b_j items and with $\sum a_i = \sum b_j$, x_{ij} represents allocation from origin i to destination j . There are mn costs associated with shipping one item from any origin to any destination and c_{ij} represents the cost associated with shipping one item from origin i to destination j .

The problem is to find the array (x_{ij}) which minimises $\sum x_{ij} \cdot c_{ij}$ subject to,

$$\begin{array}{ll} m & n \\ \sum_{i=1}^m x_{ij} = b_j \text{ for each } j & \text{and} \quad \sum_{j=1}^n x_{ij} = a_i \text{ for each } i \end{array}$$

Let us consider a specific transportation problem :

EXAMPLE 19.7.

A distributing firm dealing only in one product has three distributing centres r_1 , r_2 and r_3 located in different cities. The stock position in each of these centres is :

r_1 11 units
 r_2 13 units
 r_3 19 units

The product is sold in four different markets, c_1 , c_2 , c_3 and c_4 . The orders from these markets are 6, 10, 12 and 15 units respectively. The costs of delivering one unit of the product from each distributing centre to each market are :

	Rs.		Rs.		Rs.
r_1 to c_1	7	r_2 to c_1	5	r_3 to c_1	20
c_1	4	c_2	6	c_3	15
c_2	13	c_3	2	c_4	6
c_4	1	c_4	11	c_4	29

Determine the distribution pattern which will minimize the total delivery costs.

The solution to the problem can be found in the following manner :

Step 1. A matrix is set up as shown in Fig 19.11. The figures or values in the squares or cells are the per unit delivery costs from each distribution centre to each market. The transportation method described here has maximization of value as the objective. Maximisation of negative values causes them to approach

zero, thus resulting in minimization of the total delivery costs. This explains the use of negative sign for each value.

	c_1	c_2	c_3	c_4	Rim Value of Supply
r_1	[- 7]	[- 4]	[- 13]	[- 1]	11
r_2	[- 5]	[6]	[- 2]	[- 11]	13
r_3	[- 20]	[15]	[6]	[29]	19
Rim Value of Demand	6	10	12	15	43

Fig. 19.11. Matrix of Transportation problem

Step 2. The next step is to determine the initial feasible solution. We start allocating the units of products from the distributing centres to the markets, taking the north-west corner, i.e. r_1c_1 first. This is known as the *north-west corner rule* but we could, as we shall see later, start from any other corner as well. The rim values of r_1 and c_1 (i.e. 11 and 6) are compared and the smaller of the two, i.e. 6 is placed in the corner r_1c_1 . The demand for c_1 was 6 which has now been filled up and so in the next cell on the right, i.e. in r_1c_2 , we place 5 units to complete the supply from r_1 . We now proceed downwards and place 5 units in r_2c_2 to complete the rim value of c_2 . 8 units are then placed in r_2c_3 to complete the rim value of r_2 and then 4 units in r_3c_3 to fulfill the rim value of c_3 . Finally, placing 15 units in r_3c_4 completes the rim values of r_3 and c_4 . The first iteration matrix now takes the form as shown in Fig. 19.12.

		-7	-4	0	-23	
		c_1	c_2	c_3	c_4	Rim Value of Supply
0	r_1	[- 7] 6	[- 4] 5	[- 13]	[- 1]	11
-2	r_2	[- 5]	[- 6] 5	[- 2] 8	[- 11]	13
-6	r_3	[- 20]	[- 15]	[- 6] 4	[- 29] 15	19
	Rim Value of Demand	6	10	12	15	43

Fig. 19.12. Initial Feasible Solution

If the units are transported according to the above arrangement, the related costs will be :

$$6 \times 7 + 5 \times 4 + 5 \times 6 + 8 \times 2 + 4 \times 6 + 15 \times 29 = \text{Rs. } 567$$

This is a *feasible solution* to the problem. This is also a *basic feasible solution*. For a feasible solution to be called a basic feasible solution, the condition to be satisfied is that the number of un-occupied cells is less than or equal to $mn - m - n + 1$, (or the number of occupied cells is equal to $m + n - 1$) where m and n are the number of rows and columns respectively, in the cost matrix. Here, $m=3$ and $n=4$, $mn - m - n + 1 = 6$. In the cost matrix (Fig. 19.11), we find that there are only 6 un-occupied cells.

Step 3. The feasible solution in step 2 has to be tested for optimality. In other words, we have to find out whether this is the optimum solution, i.e. whether Rs. 567 is the minimum delivery cost. For this purpose, the row and column values and the values of the unoccupied squares are to be computed.

In computing the row and column values, only occupied rows and columns are considered and we start by placing a zero (any other number could be taken) to the left of the row of the first occupied cell, here row r_1 . The formula now adopted is :

Row value plus Column value = Value in the occupied cell

As we have taken r_1 as 0, c_1 will be -7 (so that $r_1 + c_1 = -7$, i.e. the value of occupied cell r_1c_1). The values of the other rows and columns are similarly worked out as follows :

$$\begin{aligned} c_3 &= (-)4 - 0 = (-)4 \\ r_2 &= (-)6 - (-4) = (-)2 \\ c_2 &= (-)2 - (-2) = 0 \\ r_3 &= (-)6 - 0 = (-)6 \\ c_4 &= (-)29 - (-6) = (-)23 \end{aligned}$$

The values are placed in the matrix as shown in Fig. 19.12.

Next, the un-occupied cells are evaluated in accordance with the following formula :

Row value plus Column value minus Value in un-occupied cell

$$\begin{aligned} r_1c_3 &= 0 + 0 - (-13) = 13 \\ r_1c_4 &= 0 + (-23) - (-1) = (-)22 \\ r_2c_1 &= -2 + (-7) - (-5) = (-)4 \\ r_2c_4 &= -2 + (-23) - (-11) = (-)14 \\ r_3c_1 &= -6 + (-7) - (-20) = 7 \\ r_3c_2 &= -6 + (-4) - (-15) = 5 \end{aligned}$$

The negative value in an empty cell indicates that a better solution (i.e. reduction of total delivery costs) is possible by moving in or introducing units in that cell. Introduction of units in the most negative empty cell results in greatest improvement of the solution. On the other hand, introduction of any unit in a positive value empty cell will increase the costs. A zero value in an empty cell indicates that the solution is not unique.

Step 4. We have seen that the basic feasible solution is not the optimum as several un-occupied cells have negative values. The most negative value is $(-)22$ in cell, r_1c_4 , and so, maximum possible units have to be moved into this cell first,

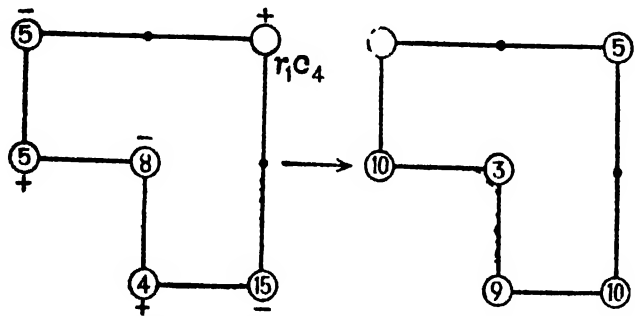
from some occupied cell. In moving in and moving out of units, three conditions are to be maintained. These are :

- (i) The rim values of the rows and columns are not to be disturbed, i.e. the 'loaded' cell which supplies units to the empty cell should be in the same row or column.
- (ii) The number of occupied cells should always be equal to, $m + n - 1$ (Here, $3 + 4 - 1 = 6$), and
- (iii) The loaded cell is so located that only one empty cell is involved in the route of movement of units.

Keeping the above conditions in view, we find that we can make the movements of units as follows :

5 units from r_1c_3 to r_1c_4
,, from r_2c_4 to r_2c_3
,, from r_3c_3 to r_3c_1 .

The positions before and after the transfers are shown below :



The matrix of the second iteration is now built up as shown in Fig. 19.13.

		-7	18	22	-1	
		c_1	c_2	-	c_4	
0	r_1	$\begin{bmatrix} -7 \\ 6 \end{bmatrix}$	$\begin{bmatrix} -4 \end{bmatrix}$	$\begin{bmatrix} -13 \end{bmatrix}$	$\begin{bmatrix} -1 \\ 5 \end{bmatrix}$	11
-24	r_2	$\begin{bmatrix} -5 \end{bmatrix}$	$\begin{bmatrix} -6 \\ 10 \end{bmatrix}$	$\begin{bmatrix} -2 \\ 3 \end{bmatrix}$	$\begin{bmatrix} -11 \end{bmatrix}$	13
-28	r_3	$\begin{bmatrix} -20 \end{bmatrix}$	$\begin{bmatrix} -15 \end{bmatrix}$	$\begin{bmatrix} -6 \\ 9 \end{bmatrix}$	$\begin{bmatrix} -29 \\ 10 \end{bmatrix}$	19
		6	10	12	15	43

Fig. 19.13. Second Iteration

Total cost now is $6 \times 7 + 5 \times 1 + 10 \times 6 + 3 \times 2 + 9 \times 6 + 10 \times 29 = \text{Rs. } 457$

The values of r and c and unoccupied cells are recomputed. It will be seen that some of the values remain unchanged. The values as they stand now are :

$r_1 = 0$
 $c_1 = (-)7$
 $c_4 = (-)1$
 $r_3 = (-)28$
 $c_2 = 22$
 $r_2 = (-)24$
 $c_3 = 18$

Values of unoccupied cells

$$r_1c_3 = 0 + 18 - (-4) = 22$$

$$r_1c_4 = 0 + 22 - (-13) = 35$$

$$r_2c_1 = -24 - 7 - (-5) = (-)26$$

$$r_2c_4 = -24 - 1 - (-11) = (-)14$$

$$r_3c_1 = -28 - 7 - (-20) = (-)15$$

$$r_3c_3 = -28 + 18 - (-15) = 5$$

The cell r_3c_1 having the greatest negative value is chosen for the introduction of units.

The empty cells may be evaluated by another method known as the *stepping stone* method, a stone denoting a unoccupied cell. Starting from the cell which is to be evaluated, move horizontally or vertically till a *stone* is reached ; add the +ive value of the cell to -ive value of the stone. Move again vertically or horizontally till a stone is reached; add to the previous total, the +ive value of the stone. Continue the process till the original cell is reached. For example, r_1c_3 in the above iteration, may be evaluated as follows :

r_1c_3 value (which we now see is the cost differential of moving one unit)

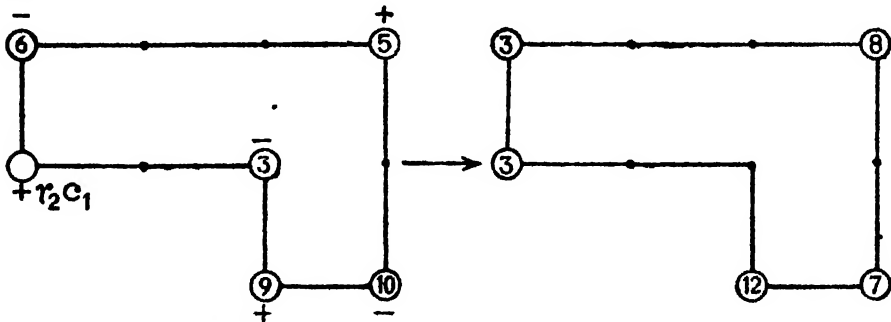
$$= \begin{matrix} 4 & -6 & +2 & -6 & +29 & -1 \end{matrix} = 22$$

$(r_1c_3) \quad (r_2c_2) \quad (r_3c_3) \quad (r_3c_4) \quad (r_2c_4) \quad (r_1c_4)$

and similarly, $r_3c_1 = 5 - 7 + 1 - 29 + 6 - 2 = -26$

One of the advantages of the stepping stone method is that it indicates clearly the route through which the movement of units will take place in the next iteration. We shall follow this method now onwards.

The positions before and after introduction of units in r_3c_1 will be as shown below :



The matrix of the third iteration will be as shown in Fig. 19.14.

	c_1	c_2	c_3	c_4	
r_1	$\begin{bmatrix} -7 \\ 3 \end{bmatrix}$	$\begin{bmatrix} -4 \end{bmatrix}$	$\begin{bmatrix} -13 \end{bmatrix}$	$\begin{bmatrix} -1 \\ 8 \end{bmatrix}$	11
r_2	$\begin{bmatrix} -5 \\ 3 \end{bmatrix}$	$\begin{bmatrix} -6 \\ 10 \end{bmatrix}$	$\begin{bmatrix} -2 \end{bmatrix}$	$\begin{bmatrix} -11 \\ 1 \end{bmatrix}$	13
r_3	$\begin{bmatrix} -20 \end{bmatrix}$	$\begin{bmatrix} -15 \end{bmatrix}$	$\begin{bmatrix} -6 \\ 12 \end{bmatrix}$	$\begin{bmatrix} -20 \\ 7 \end{bmatrix}$	19
	6	10	12	15	43

Fig. 19.14. Third Iteration

The total cost = $3 \times 7 + 8 \times 1 + 3 \times 5 + 10 \times 6 + 12 \times 6 + 7 \times 29 = \text{Rs. } 379$.

The square evaluation of the empty cells will be :

$$r_1c_3 = 4 - 6 + 5 - 7 = (-) 4$$

$$r_1c_2 = 13 - 1 + 29 - 6 = 35$$

$$r_3c_3 = 2 - 6 + 29 - 1 + 7 - 5 = 26$$

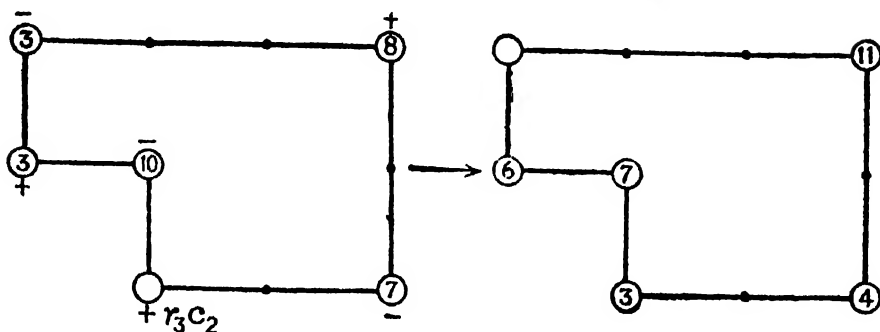
$$r_2c_1 = 11 - 5 + 7 - 1 = 12$$

$$r_3c_1 = 20 - 7 + 1 - 29 = (-) 15$$

$$r_3c_2 = 15 - 29 + 1 - 7 + 5 - 6 = (-) 21$$

The most negative cell is r_3c_2 .

The positions before and after introduction of units in r_3c_2 will be :



The matrix for the fourth iteration is shown in Fig. 19.15.

	c_1	c_2	c_3	c_4	
r_1	$[-7]$	$[-4]$	$[-13]$	$[-1]$ 11	11
r_2	$[-5]$ 6	$[-6]$ 7	$[-3]$	$[-11]$	13
r_3	$[-20]$	$[-15]$ 3	$[-6]$ 12	$[-29]$ 4	19
	6	10	12	15	43

Fig. 19.15. Fourth Iteration

The total delivery cost = $11 \times 1 + 6 \times 5 + 7 \times 6 + 3 \times 15 + 12 \times 6 + 4 \times 29 = \text{Rs. } 316$

Square evaluation will be :

$$r_1c_1 = 7 - 1 + 29 - 15 + 6 - 5 = 21$$

$$r_1c_2 = 4 - 1 + 29 - 15 = 17$$

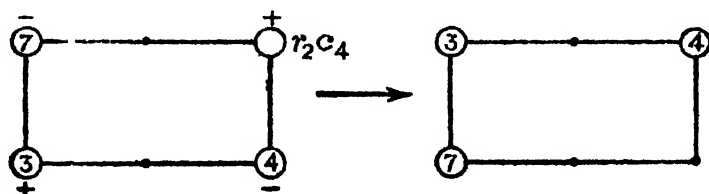
$$r_1c_3 = 13 - 1 + 29 - 6 = 35$$

$$r_3c_3 = 2 - 6 + 15 - 6 = 5$$

$$r_2c_4 = 11 - 29 + 15 - 6 = (-) 9$$

$$r_3c_1 = 20 - 5 + 6 - 15 = 6$$

The only negative value cell is r_2c_4 to which units will be introduced. The positions before and after movement of units will be as follows :—



The matrix for the fifth iteration is shown in Fig. 19.16.

	c_1	c_2	c_3	c_4	
r_1	[-7]	[-4]	[-13]	[-1]	11
r_2	[-5] 6	[-6] 3	[-2]	[-11] 4	13
r_3	[-20]	[-15] 7	[-6] 12	[-29]	19
	6	10	12	15	43

Fig. 19.16. Fifth Iteration --Optimum Solution

Total delivery cost = $11 \times 1 + 6 \times 5 + 3 \times 6 + 4 \times 11 + 7 \times 15 + 12 \times 6 = \text{Rs. } 280$

Square evaluation will be :

$$\begin{aligned}
 r_1c_1 &= 7 - 5 + 11 - 1 = 12 \\
 r_1c_2 &= 4 - 6 + 11 - 1 = 8 \\
 r_1c_3 &= 13 - 1 + 11 - 6 = 17 \\
 r_2c_2 &= 2 - 6 + 15 - 6 = 5 \\
 r_2c_1 &= 20 - 15 + 6 - 5 = 6 \\
 r_2c_4 &= 29 - 11 + 6 - 15 = 9
 \end{aligned}$$

As there is no negative value, the optimum solution has now been reached. Thus, the fifth iteration in this case is the final iteration and the optimum cost of delivery is Rs. 280.

A simpler method of finding a feasible solution is a short cut method, known as *Vogel's approximation method* (VAM). The advantage of this method is that several of the earlier iteration steps may be eliminated and at the beginning itself a feasible solution with lower cost is obtained. First, the cost, demand, and supply matrix is written as follows :

	c_1	c_2	c_3	c_4	Supply
r_1	7	4	13	1	11
r_2	5	6	2	11	13
r_3	20	15	6	29	19
Demand	6	10	12	15	

The next step is to examine each of the cost elements and find out the difference between the smallest and the second smallest element in each column and in each row and write these differences in parentheses below the respective columns and along side the respective rows.

	c_1	c_2	c_3	c_4	Supply
r_1	7	4	13	1 11	11 (3)
r_2	5	6	2	11 4	13 (3)
r_3	20	15	6	29	19 (9)
Demand	6 (2)	10 (2)	12 (4)	15 (10) ↑	

(For column c_1 , the difference is 7 minus 5 = 2, and so on.)

In the next step, we start allocating, starting with the column or row which has the largest number in the parenthesis. Here, allocation will be made to c_4 which has the largest number, i.e. 10, in the parenthesis. In this column, r_1c_4 has the minimum cost and so allocation to this location is made as much as possible to minimize cost. The next allocation is made to the element of this column which has the next lower cost, and so on. In the example, 11 units are allocated to r_1c_4 and 4 units to r_2c_4 . The revised or shrunken matrix is written next, leaving out column c_4 . The differences are then reworked and written in the parenthesis.

	c_1	c_2	c_3	
r_1	7	4	13	0 (3)
r_2	5	6	2	9 (3)
r_3	20	15 7	6 12	19 (9) ←
	6 (2)	10 (2)	12 (4)	

The largest difference (9) is now in row r_3 and so allocations are made to this row selecting first r_3c_3 , i.e. the element with the least cost. In the next shrunken matrix, row r_3 is left out and the procedure is repeated till all the allocations are completed.

	c_1	c_2	c_3	
r_1	7	4	13	0 (3)
r_2	5 6	6 3	2	9 (3)
	6 (2)	3 (2)	0 (11)	

Putting all the allocations together, the matrix will be as follows and the cost

	c_1	c_2	c_3	c_4	
r_1				11	11
r_2	6	3		4	13
r_3		7	12		19
	6	10	12	15	

for this solution is Rs. 280. It will be seen that per chance, this is the optimum solution (see Fig. 19.16). If this were not so, further iterations would have been made starting with this initial allocation.

Dummy Row or Column. In the example given above, the demand and supply were taken to be identical. Such situations may not be very common and the demand often exceeds the supply or the supply exceeds the demand. Such problems are solved by introducing a dummy column for demand or a dummy row for supply containing the requisite units of demand or supply, as the case may be, to make demand and supply equal. The dummy square is given a zero value on the basis that it costs nothing to supply units to a dummy customer or receive units from a dummy supplier. The problem is then solved in the usual manner by the process of moving units and successive iteration till the optimum solution is obtained.

This is illustrated in the example below :

EXAMPLE 19.8.

A company has three plants located at different places but producing an identical product. The cost of production, distribution cost for each plant to three different warehouses, sale price at each warehouse and individual capacities for both the plant and the warehouse are given below :

		(Figs. in Rupees)			Sale price (Rs.)	Warehouse capacity (Nos.)
Plants		F_1	F_2	F_3		
Raw material		15	18	14		
Other expenses		10	9	12		
Warehouses to		Distribution cost			Sale price (Rs.)	Warehouse capacity (Nos.)
W_1		3	9	5	34	80
W_2		1	7	4	32	110
W_3		5	8	3	31	150
Capacity of Plant (Nos.)		150	100	130		

Establish a suitable table giving net profit/loss for a unit produced at different plants and distributed at different locations.

Introduce a suitable dummy warehouse/plant so as to match the capacities of plants and warehouses.

Find a distribution pattern which maximizes profit or minimises loss. (I.C.W.A., Final)

ANSWER :

The distribution pattern with profit shown as negative (this being a problem of maximisation) is as follows :

	F_1	F_2	F_3	
W_1	-6	2	-3	80
W_2	-6	2	-2	110
W_3	-1	4	-2	150
	150	100	130	

A dummy warehouse, W_4 , is introduced with zero cost and zero profit to balance the excess production of 40 units. The distribution now is :

	F_1	F_2	F_3	
W_1	-6	2	-3	80
W_2	-6	2	-2	110
W_3	-1	4	-2	150
W_4	0	0	0	40
	150	100	130	380

The first iteration will be :

	F_1	F_2	F_3	
W_1	$[-6]$ 80	[2]	[-3]	80
W_2	$[-6]$ 70	[2] 40	[-2]	110
W_3	[-1]	[4] 60	[-2] 90	150
W_4	[0]	[0]	[0] 40	40
	150	100	130	

The evaluation of the empty cells will be :

$$\begin{aligned}
 W_1F_3 &= 2 - (-6) + (-6) - 2 = 0 \\
 W_1F_2 &= -3 - (-6) + (-6) - 2 + 4 - (-2) = 1 \\
 W_2F_3 &= -2 - 2 + 4 - (-2) = 2 \\
 W_3F_1 &= -1 - (-6) + 2 - 4 = 3 \\
 W_4F_1 &= 0 - (-6) + 2 - 4 + (-2) = 0 = 2 \\
 W_4F_3 &= 0 - 4 + (-2) - 0 = -6
 \end{aligned}$$

W_4F_3 having a negative value, we may transfer 2 units to that cell. The next iteration will thus be :

	F_1	F_2	F_3	
W_1	80			80
W_2	70	40		110
W_3		20	130	150
W_4		40		40
	150	100	130	

The evaluations of the empty cells are now :

$$\begin{aligned}
 W_1F_3 &= 2 - 2 + (-6) - (-6) = 0 \\
 W_1F_2 &= -3 - (-6) + (-6) - 2 + 4 - (-2) = 1 \\
 W_2F_3 &= -2 - 2 + 4 - (-2) = 2 \\
 W_3F_1 &= -1 - (-6) + 2 - (4) = 3 \\
 W_4F_1 &= 0 - (-6) + 2 - 0 = 8 \\
 W_4F_2 &= 0 - 0 + 4 - (-2) = 6
 \end{aligned}$$

As all the values are non-negative, we have arrived at the optimum solution with a maximum profit of Rs. 1,000.

(The zero value of W_2F_3 indicates that the solution is not unique and there is an alternative distribution pattern with the same amount of profit.)

In complex distribution problems, situations arise when a given factory-warehouse route is prohibited. In such cases, the solution is arrived at by crossing out or blocking out the particular square which has been prohibited so that in all distribution patterns this square is skipped as if it did not exist. An alternative method is to allot a very high negative value, higher than any of the other values, to the prohibited square so that this square is not selected for moving in the units or if at all any units are moved, it is immediately vacated at the earliest opportunity.

Degeneracy. We had seen that in a transportation problem, a solution can be a basic feasible solution only if,

$$\text{Number of empty cells} \leq mn - m - n + 1, \text{ or}$$

$$\text{Number of occupied cells} = m + n - 1$$

When the above conditions are not satisfied, e.g. when the number of occupied cells is less than $m + n - 1$, the problem is said to be *degenerate*. Degeneracy may occur in the initial solution or in any subsequent feasible solution. A degenerate problem cannot be solved unless it is modified so that the above conditions are satisfied.

In the process of iteration, we may come across two stones each having the same number of units, all of which are to be moved out, so that in the next iteration these will be unoccupied and only one new cell will be occupied. The number of occupied cells will thus be, $m + n - 2$. If several stones to be moved out have equal unit value, the number of occupied cells will be even less than $m + n - 2$. The problems in such cases become degenerate. Let us consider the following situation, (Fig. 19.17) which is a case of degeneracy.

	X	Y	Z	Supply
A	$[-5]$ 50	$[-10]$	$[-2]$	50
B	$[-3]$ 5	$[-7]$ 10	$[-5]$	15
C	$[-6]$	$[-8]$ 5	$[-4]$ 25	30
Dummy D	(0)	(0)	(0) 5	5
Demand	55	15	30	100

Fig. 19.17. Degenerate Condition

In the above illustration CY and DZ have stones each having the same unit value, viz. 5, which are to be moved out. In the next iteration, CY and DZ will be unoccupied and DY will be the only new cell occupied. Thus the number of occupied cells will be only 5, i.e. one less than the required number, namely, 6 (i.e. $m + n - 1 = 4 + 3 - 1 = 6$).

In order to remove degeneracy, one method is to put zero unit value in one of the cells just unoccupied, i.e. either in CY or DZ and for the propose of calculation, this square is treated as an occupied square. The subsequent processes of iteration are now carried out in the usual manner till the optimum solution is arrived at. The choice of one or the other of the unoccupied cells for placing therein zero unit value, is immaterial so long as the process continues smoothly and the optimum solution is reached. In some cases, however, the choice of a particular unoccupied cell may result in *cycling*, i.e. some iterations will move away from the optimum and their solution pattern will be repeated in a cycling process. In other words, one of the earlier iteration solutions will reappear. In such a case, cycling can be avoided by repeating the iteration in which zero unit value was introduced by inserting the zero unit value in a possible location other than the one which resulted in cycling.

Degeneracy with its characteristic feature of cycling occurs also in the case of linear programming problems solved by the simplex method. This can be avoided by various methods similar to those used in transportation problems. These have not been discussed here.

ASSIGNMENT PROBLEM

The problem of assignment may be stated thus :

There are a number of men (m) of different capacities available for performing each job and there are the same number of jobs (n) of different types and one man can be given one and only one job. If the cost C_{ij} of assigning any man (i) to any job (j) is given, the assignment problem is to determine which job will be assigned to which man so that the cost is minimum.

Expressing mathematically, the problem is :

$$\text{Minimise} \quad \sum_{j=1}^n \sum_{i=1}^n X_{ij} C_{ij}$$

Subject to

$$\sum_{j=1}^n X_{ij} = 1$$

$$\sum_{i=1}^n X_{ij} = 1$$

$$X_{ij} = 0 \text{ or } 1$$

It will be seen that assignment problem represents a special case of transportation problem. Here, $m = n$, and all $a_i = 1$ and all $b_j = 1$ and each x_{ij} is limited to one of the two values 0 and 1. Therefore, exactly n of the x_{ij} can be non-zero, one in each row of the array and one in each column. It may also be proved that an assignment problem does not change its structure if each row and column is reduced by a constant. The above properties assist in the determination of the solution to an assignment problem. This is illustrated below :

EXAMPLE 19.9.

Six salesmen are to be allocated to six sales regions so that the cost of allocation of the job will be minimum.

Each salesmen is capable of doing the jobs at different costs in each region. The cost matrix is given below.

Region	I	II	III	IV	V	VI
Salesmen						
A	15	35	0	25	10	45
B	40	5	45	20	15	20
C	25	60	10	65	25	10
D	25	20	35	10	25	60
E	30	70	40	5	40	50
F	10	25	30	40	50	15

(Figures are in Rs.)

(a) Find the allocation to give the minimum cost. What is this cost ?

(b) Now suppose the above table gives earnings of each salesman at each region. How can you find an allocation so that the earning will be maximum ? Derive the solution with optimum earning.

(c) There are restrictions for commercial reasons that A cannot be posted to region V and E cannot be posted to region II.

Write down the cost matrix suitably after imposing the restriction. Suggest how to solve it. (I.C.W.A., Final)

ANSWER :

(a) In the first step, the minimum value element of each row is subtracted from the other elements of the row (e.g. 0 in the first row, 5 in the second row, and so on) to give the transposed matrix as follows :

	I	II	III	IV	V	VI
A	15	35	0	25	10	45
B	35	0	40	15	10	15
C	15	50	0	55	15	0
D	15	10	25	0	15	50
E	25	65	35	0	35	45
F	0	15	20	30	40	5

This and the subsequent steps do not change the value of the matrix. This, however, is not the optimum solution because the optimum solution must contain atleast one zero in each row and each column. The optimality may be tested thus :

Draw straight lines passing through the rows and/or columns in such a manner that each line crosses atleast one zero element and the number of lines drawn should be the minimum which would be necessary for passing through all zero elements in the matrix. We find here that five lines can be drawn as shown in the above matrix. Now the condition for optimality is that the number of such minimum lines should not be less than the rank of the matrix. In this case, the rank of the matrix is six and so optimality has not been reached and we pass on to the next step.

The minimum value element of each column is now deducted from the other elements of the column, as follows :

	I	II	III	IV	V	VI
A	15	35	0	25	0	45
B	35	0	40	15	0	15
C	15	50	0	55	5	0
D	15	10	25	0	5	50
E	25	65	35	0	25	45
F	0	15	20	30	30	5

The lines passing through zeros are drawn as in the previous step. We find that the minimum number of lines is still five and so optimality has not yet been reached.

In the subsequent step, the minimum value element through which no line passes is picked up (5 in this case). This element is (i) deducted from all other elements through which no lines pass and (ii) added to each of the elements through which no two lines intersect. In the present case, the smallest such element is 5.

The matrix takes the following form after carrying out this operation :

	I	II	III	IV	V	VI
A	15	35	0	30	25	45
B	35	0	40	20	25	15
C	15	50	25	60	5	0
D	10	5	20	25	0	45
E	20	60	30	0	20	40
F	0	15	20	35	30	5

The minimum number of lines which pass through all the zeros in the above matrix is six, so that the optimal solution has now been reached. (If otherwise, this process would have been continued till the optimum solution was reached.)

To find out the solution, mark all zero's (say, within a square cage) wherever there is a single zero in a row or a column and cross out the rest of the zeros appearing in the corresponding columns and rows, as shown in the above matrix. The marked zeros are the allocations or assignments to be made and having once done that, the crossed out zeros indicate that the relevant row or column is no longer available for further assignment. In this case, E has only one zero, i.e. in IV ; this is marked (IV is assigned to E) and zero in column IV against D is crossed being no longer available. Next, I is assigned to F, there being no other zero in the row or column. The next assignment is V to D (being the only zero now, the other one having already been crossed out) and the zeros in this column against A and B are crossed out. This enables us to now assign III to A (crossing out the other zero in this column) and II to B. The only region left is VI which is assigned to C. The optimal solution, therefore is :

Salesman	Region allotted	Cost (Rs.)
A	III	0
B	II	5
C	VI	10
D	V	25
E	IV	5
F	I	10
	Minimum cost	55

(Note : Sometimes the above operations result in more than one solution, each of which is optimal giving the minimum cost. In such cases, the alternative to be selected is decided by taking into account other factors relevant to the situation such as suitability of a man, locality etc.)

(b) The problem of maximisation is solved in the same manner as the minimisation problem except that in the first step, the element values in each row are deducted from the maximum value element in that row. Alternatively, the same matrix is obtained in the first step if all the elements of the problem matrix are multiplied by $(-)$ 1.

Thus after carrying out the first step, the matrix will take the following form :

	I	II	III	IV	V	VI
A	30	10	45	20	35	0
B	5	40	0	25	30	25
C	40	5	5	0	40	55
D	35	40	25	50	35	0
E	40	0	30	65	30	20
F	40	25	20	10	0	35

In the next step, the element with the minimum value in each column is deducted from all the other elements in that column to give the following matrix :

	I	II	III	IV	V	VI
A	25	10	45	20	35	0
B	0	0	0	25	30	25
C	35	5	55	0	40	55
D	30	40	25	50	35	0
E	35	0	30	65	30	20
F	35	25	20	10	0	35

The optimal solution has not yet been reached ; so the subsequent process of deducting the minimum value elements from the elements through which no line passes and adding the same to

intersection points of two lines are carried out. The next matrix gives two alternative optimum solutions of identical value, as follows :

	I	II	III	IV	V	VI
A	10	10	20	20	10	20
B	20	65	30	50	30	50
C	10	5	30	10	15	55
D	5	40	20	50	10	10
E	10	10	5	65	5	20
F	35	50	20	35	10	60

	I	II	III	IV	V	VI
A	20	10	20	20	10	10
B	10	65	20	50	30	50
C	10	5	30	10	15	55
D	5	40	10	50	10	20
E	10	10	5	65	5	20
F	35	50	20	35	10	60

The optimal solutions are :

Salesman	Region		Earnings (Rs.)	
A	I	VI	15	45
B	III	I	45	40
C	IV	IV	65	65
D	VI	III	60	35
E	II	II	70	70
F	V	V	50	50
Maximum earnings			305	305

(c) A very high value M or α is placed in the restricted element so that the matrix will now be :

	I	II	III	IV	V	VI
A	15	35	0	25	α	45
B	40	5	45	20	15	20
C	25	60	10	65	25	10
D	25	20	35	10	25	60
E	30	α	40	5	40	50
F	10	25	30	40	50	15

The usual operations are now carried out. Deducting the least value element in each row from the rest of the elements in the row, we get the following matrix :

	I	II	III	IV	V	VI
A	15	35	0	25	α	45
B	35	0	40	15	10	15
C	15	50	0	55	15	0
D	15	10	25	0	15	50
E	25	α	35	0	35	45
F	0	15	20	30	40	5

Deducting the least value element in each column from the other elements in the column, we get :

	I	II	III	IV	V	VI
A	15	25	0	25	α	45
B	35	0	0	15	0	15
C	15	50	0	55	15	0
D	15	10	25	0	5	50
E	25	α	35	0	25	45
F	0	15	20	30	30	5

Since the optimal solution has not yet been reached, the minimum value element among the elements through which no lines pass is deducted from all such elements and added to the elements at the intersections of two lines, as follows :

	I	II	III	IV	V	VI
A	10	30	<u>0</u>	25	∞	40
B	<u>0</u>	<u>0</u>	45	20	∞	15
C	15	50	5	60	5	<u>0</u>
D	40	5	25	∞	<u>0</u>	45
E	20	∞	35	<u>0</u>	20	40
F	<u>0</u>	15	25	35	30	15

The optimal solution has now been reached. This is :

Salesman	Region assigned	Cost (Rs.)
A	III	0
B	II	5
C	VI	10
D	V	25
E	IV	5
F	I	10
	Minimum cost	55

It will be noted that the above solution is identical to the solution of the main problem. This is because even without the restrictions imposed, the assignments to A and E were not affected.

Problems with non-square matrices may also be solved by the above method by introducing a number of dummies as necessary so that a square matrix is formed. The dummies are assigned zero costs and so they do not affect the final solution. For example, we may assume that there are 6 men and only 4 jobs, and the cost matrix is as follows :

Jobs	1	2	3	4
Men				
A	3	5	5	7
B	6	2	5	7
C	4	6	5	8
D	9	5	9	2
E	5	4	3	1
F	8	7	1	9

After introduction of two dummy jobs with zero costs, the matrix becomes :

	1	2	3	4	5	6
A	3	5	5	7	0	0
B	6	2	5	7	0	0
C	4	6	5	8	0	0
D	9	5	9	2	0	0
E	5	4	3	1	0	0
F	8	7	1	9	0	0

Now proceeding to solve the problem in the usual manner (we start with the 2nd step, i.e. deducting the least element in a column from the other elements in the column, there is already a zero in each row), the solution matrix is :

	1	2	3	4	5	6
A	<u>0</u>	3	4	6	0	0
B	3	<u>0</u>	4	6	0	0
C	1	4	4	7	0	0
D	6	3	8	1	0	0
E	2	2	<u>0</u>	<u>0</u>	0	0
F	5	5	<u>0</u>	8	0	0

and the solution is :

Man	Job	Cost
A	1	3
B	2	2
E	4	1
F	3	1

	Minimum cost	7

QUEUING THEORY OR WAITING LINE MODELS

An introductory paragraph on Queuing Theory or Waiting Line Models is given on Page 927 in this chapter.

In building queuing models, the following patterns and situations should be understood :

1. *Arrival patterns (V)* : Arrival pattern is specified by the inter-arrival time, i.e. the time between successive customer arrivals. An arrival pattern may be deterministic, i.e. it may be known exactly or it may have a random value whose probability distribution is presumed to be known. The pattern may be in independent state or it may be dependent on the number of customers already in the queue.

In the context of arrival patterns, two terms are commonly used, viz. (i) *Balking*, that occurs when a customer refuses to enter the service facility because the queue is too long and (ii) *Reneging*, that refers to a customer already in the queue leaving the facility because waiting is too long.

2. *Service pattern (W)* : This is specified by the service time, i.e. the time required by a server to serve one customer. Like the arrival pattern, a service pattern may be either deterministic or follow a distribution pattern presumed as known and it may be in independent state or in dependent state.

In building queuing models, an assumption usually made is that a customer is served completely and not by a series of services.

3. *System capacity (Y)* : The waiting system may be finite or infinite. When the system is full, there is no entry to the service facility and there is no waiting in the queue as well. In such a situation, the maximum available server equals the maximum customers permitted in a queue and service facility, at a time.

4. *Queue disciplines (Z)* : A queue discipline denotes the order in which customers are served. This may be on FCFS or FIFO (first come first served), LCFS or LIFO (last come served first), random or priority basis.

When Y and Z are not specified, the assumption made is that $Y = \infty$ and Z is FIFO basis.

The results mainly to be obtained from an analysis of queuing system are :

1. Average number of customers in the system (L)
2. Average length of queue (L_q)
3. Average time a customer spends in the system (W)
4. Average time a customer spends or waits in the queue (W_q)
5. Probability that a customer spends more than t units of time in the system ($W(t)$)

6. Probability that a customer spends more than t units of time in the queue ($W_q(t)$)
7. Probability of n customers in the system (P_n)
8. Chance of the service facility being idle, i.e. no customer in the system (P_0)

Analysis of Queuing Systems. We consider here queuing models under two situations, viz. (i) Single service facility with infinite population and (ii) Multiple service facilities with infinite population. The formulations of the models have been stated for the purpose of arriving at the various results, without going into the basic mathematical derivations of the formulae.

A. Single service facility : The conditions assumed are :

- (i) Infinite population
- (ii) Single entry
- (iii) Inter-arrival time and service time follow exponential distribution
- (iv) Arrival and services follow Poisson distribution
- (v) Arrival and service are independent of each other
- (vi) Queue discipline is FIFO
- (vii) Average number of arrivals per unit of time is denoted by λ and average number of services that can be performed is denoted by μ , μ being greater than λ .

The various formulae are :

1. Average number of units or customers in the system (average length)
(A system consists of units in the queue plus units in service line).

$$L = \frac{\lambda}{\mu - \lambda}, \quad [\text{or} = L_q + \frac{\lambda}{\mu}]$$

2. Average number of units or customers in the queue (average length)

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)},$$

$$[\text{or} = \text{Average number in system} - \text{expected number in service} = \frac{\lambda}{\mu - \lambda} - \frac{\lambda}{\mu}]$$

3. Average time spent by a customer in the system (average waiting time of an arrival in the system)

$$W = \frac{\text{Average number in system}}{\text{Average rate of arrival}} = \frac{L}{\lambda} = \frac{1}{\mu - \lambda}, \quad [\text{or} = W_q + \frac{1}{\mu}]$$

4. Average time spent by a customer in the queue (average waiting time of an arrival)

$$W_q = \frac{\text{Average number in queue}}{\text{Average rate of arrival}} = \frac{L_q}{\lambda} = \frac{\lambda}{\mu(\mu - \lambda)}$$

(Unless specified otherwise, average waiting time refers to the waiting time in the queue).

5. Probability that a customer spends more than t units of time in the system

$$W(t) = e^{-(\lambda - \mu)t}$$

6. Probability that a customer spends more than t units of time in the queue

$$W_q(t) = \frac{\lambda}{\mu} e^{-(\mu - \lambda)t}$$

7. Probability of n customers in the system

$$P_n = \left(1 - \frac{\lambda}{\mu}\right) \left(\frac{\lambda}{\mu}\right)^n$$

8. Probability of no customer in the system (idle service facility).

$$P_0 = 1 - \frac{\lambda}{\mu}$$

9. Probability that the queue size is greater than or equal to k

$$P_n \geq k = \left(\frac{\lambda}{\mu}\right)^k$$

$$[P_n \geq k = \sum_{n=0}^{\infty} P_n - (P_0 + P_1 + P_2 + \dots + P_{k-1})]$$

$$= 1 - [P_0 + \frac{\lambda}{\mu} P_0 + \left(\frac{\lambda}{\mu}\right)^2 P_0 + \dots + \left(\frac{\lambda}{\mu}\right)^{k-1} P_0] = \left(\frac{\lambda}{\mu}\right)^k$$

10. Average length of a non-empty queue

$$= \frac{\text{Average length of a queue}}{\text{Probability of non-empty queue}} = \frac{\lambda^2}{\mu(\mu - \lambda)} \left(\frac{\lambda}{\mu}\right)^2 \frac{\mu}{\mu - \lambda}$$

[Since there should be atleast 2 units in a non-empty system, viz. one in the queue and the other in service, probability of a non-empty queue $\sum_{n=0}^{\infty} P_n - (P_0 + P_1) = \left(\frac{\lambda}{\mu}\right)^2$]

An example to illustrate the calculations made on the basis of some of the above formulations is given below.

EXAMPLE 19.10.

A repair shop attended by a single mechanic has an average of four customers an hour who bring small appliances for repair. The mechanic inspects them for defects and quite often can fix them right away or otherwise render a diagnosis. This takes him six minutes on the average for each service. Arrivals are Poisson and service time has the exponential distribution. You are required to :

- Find the proportion of time during which the shop is empty ,
- Average number of customers in the system and in the queue ,
- Average time spent including services ;
- Probability of 5 customers in the system ,
- Probability that the queue size is greater than 3 ;
- Probability that a customer spends more than 2 hours in the queue

(I.C.W.A., Final Adapted)

ANSWER :

Here, $\lambda = 4$ per hour and $\mu = 10$ per hour

$\therefore \frac{\lambda}{\mu} = 0.4$ (This denotes the utilization factor, i.e. the probability that the service facility is busy.)

$$(a) P_0 = 1 - \frac{\lambda}{\mu} = 1 - 0.4 = 0.6$$

$$(b) L = \frac{\lambda}{\mu - \lambda} = \frac{4}{10 - 4} = 0.667$$

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{4^2}{10(10 - 4)} = 0.2667$$

$$(c) W = \frac{1}{\mu - \lambda} = \frac{1}{10 - 4} = \frac{1}{6} \text{ hour} = 10 \text{ minutes}$$

$$(d) P_5 = \left(1 - \frac{\lambda}{\mu}\right) \left(\frac{\lambda}{\mu}\right)^5 = (1 - 0.4)(0.4)^5 = 0.0064$$

$$(e) P_n \geq 3 = \left(\frac{\lambda}{\mu}\right)^3 = (0.4)^3 = 0.064$$

$$(f) W_q(2) = \frac{\lambda}{\mu} e^{-(\mu - \lambda)^2} = 0.4 \times e^{-(-0.6)^2} = 0.4 \times 0.06985 = 0.2794$$

(Value of $e^{-0.36}$ is obtained from table)

If the arrivals are through more than one channel, the formulae will be as given below, assuming service rate μ , M channels, arrival rate λ in each channel and all the other notations used in the previous section.

1. Probability of n customers in the system

$$P_n = P_0 \left(\frac{\lambda}{\mu}\right)^n \cdot \frac{M}{|M-n|}$$

2. Probability of an empty system

$$P_0 = \frac{1}{1 + \frac{\lambda}{\mu} \cdot \frac{|M|}{|M-1|} + \left(\frac{\lambda}{\mu}\right)^2 \cdot \frac{|M|}{|M-2|} + \dots}$$

(Since $P_0 + P_1 + P_2 + \dots = 1$)

3. Average number of customers in the system

$$L = P_0 \frac{\lambda}{\mu} \cdot \frac{|M|}{|M-1|} + 2P_0 \cdot \left(\frac{\lambda}{\mu}\right)^2 \cdot \frac{|M|}{|M-2|} + \dots$$

(or $1P_1 + 2P_2 + 3P_3 + \dots$)

The application of these formulae is illustrated in the example given below :

EXAMPLE 19.11

In machine maintenance, a mechanic repairs 4 machines. The mean time between service requirement is 5 hours for each machine and forms an exponential distribution. The repair time is one hour and also follows the same distribution pattern. Machine downtime costs Rs. 25 per hour and the mechanic costs Rs. 55 per day of 8 hour

You are required to :

- 1) Find the expected number of operating machines ;
- 2) Determine the expected downtime cost per day ;

Would it be economical to engage 2 mechanics each repairing only 2 machines ?

(I. C. W. A., Final)

ANSWER :

$$M = 4, \lambda = 1/5 \text{ hour}, \mu = 1 \text{ hour}, \frac{\lambda}{\mu} = 0.2$$

$$\begin{aligned} P_0 &= \frac{1}{1 + \frac{\lambda}{\mu} \cdot \frac{|M|}{|M-1|} + \left(\frac{\lambda}{\mu}\right)^2 \cdot \frac{|M|}{|M-2|} + \left(\frac{\lambda}{\mu}\right)^3 \cdot \frac{|M|}{|M-3|} + \left(\frac{\lambda}{\mu}\right)^4 \cdot \frac{|M|}{|M-4|}} \\ &= 1 / (1 + 0.2 \cdot \frac{4}{3} + 0.2^2 \cdot \frac{4}{2} + 0.2^3 \cdot \frac{4}{1} + 0.2^4 \cdot \frac{4}{0}) \\ &= 1 / (0.8 + 0.48 + 0.192 + 0.0384) = 0.4 \end{aligned}$$

Average number of machines in the system

$$L = P_0 \cdot \frac{\lambda}{\mu} \cdot \frac{|M|}{|M-1|} + 2P_0 \cdot \left(\frac{\lambda}{\mu}\right)^2 \cdot \frac{|M|}{|M-2|} + 3P_0 \cdot \left(\frac{\lambda}{\mu}\right)^3 \cdot \frac{|M|}{|M-3|} + 4P_0 \cdot \left(\frac{\lambda}{\mu}\right)^4 \cdot \frac{|M|}{|M-4|}$$

(or $= 1P_1 + 2P_2 + 3P_3 + 4P_4$)

$$= 0.4(0.2 \times \frac{4}{4-3} + 0.2^2 \times \frac{4}{4-2} + 0.2^3 \times \frac{4}{4-1} + 0.2^4 \times \frac{4}{4-0}) = 0.996 \text{ or } 1$$

1) Expected number of operating machines = $4 - 1 = 3$

2) Expected downtime cost (in respect of non-operating machine)

$$= 1 \times 8 \text{ hours} \times \text{Rs. } 25 = \text{Rs. } 200$$

$$\text{Total cost} = \text{Rs. } 200 + \text{Rs. } 55 = 255$$

If 2 mechanics each attend 2 machines,

$$P_0 = \frac{1}{1 + 0.2 \frac{2}{2-1} + 0.2^2 \frac{2}{2-2}} = \frac{1}{1 + .4 + .08} = 0.68$$

Total downtime for a group of 2 machines = $0.38 \times 8 \text{ hours} = 3.04 \text{ hrs.}$

Total downtime for a group of 4 machines = $3.04 \times 2 \text{ hours} = 6.08 \text{ hrs.}$

∴ Saving = $8 - 6.08 = 1.92 \text{ hrs. per day}$

B. Multiple service facility : The conditions assumed are the same as in single service facility model except that there are c service channels for one waiting line. Some of the formulae are :

1. Average number of customers in the system

$$L = L_q + \frac{\lambda}{\mu} = \frac{\lambda \mu \left(\frac{\lambda}{\mu} \right)^c}{c-1 (c\mu - \lambda)^2} \cdot P_0 + \frac{\lambda}{\mu}$$

2. Average queue length

$$L_q = \frac{\lambda \mu \left(\frac{\lambda}{\mu} \right)^c}{c-1 (c\mu - \lambda)^2} P_0$$

3. Average waiting time in the system

$$W = \frac{L}{\lambda} = \frac{\mu(\lambda - \mu)^c}{c-1 (c\mu - \lambda)^2} \cdot P_0 + \frac{1}{\lambda}$$

4. Average waiting time in queue (average waiting time of an arrival)

$$W_q = \frac{L_q}{\lambda} = \frac{\mu(\lambda - \mu)^c}{c-1 (c\mu - \lambda)^2} \cdot P_0$$

5. Probability of idle service in the system

$$P_0 = \frac{1}{\left[\sum_{n=0}^{c-1} \frac{(\lambda/\mu)^n}{n!} \right] + \frac{(\lambda/\mu)^c}{c! \left(1 - \frac{\lambda}{c\mu} \right)}}$$

6. Probability of n customers in the system

(i) If $n < c$ ($n = 0, 1, 2, \dots, c-1$),

$$P_n = P_0 \frac{(\lambda/\mu)^n}{n!}$$

(ii) If $n > c$,

$$P_n = P_0 \frac{(\lambda/\mu)^n}{c! c^{(n-c)}}$$

7. Utility factor (probability that all service facilities are simultaneously serviced)

$$= \frac{1}{c!} (\lambda/\mu)^c \cdot \frac{c\mu}{c\mu - \lambda} \cdot P_0$$

EXAMPLE 19.12.

A bank has opened three foreign exchange counters for its clients who are attended to on the first come first served basis. Each counter is manned by one clerk and counters remain open from 10 A.M. to 2 P.M. every day, 5 days a week. It is found that persons seeking this service arrive according to Poisson distribution pattern at an average rate of 20 per day. The time spent by each clerk with a client is found to have an exponential distribution with an average service time of 20 minutes.

You are required to compute :

- The hours in a week which a clerk expects to spend with the clients ;
- The average time a client spends in the bank.

ANSWER :

Here, $\lambda = \frac{20}{4}$ 5 arrivals per hour

$\mu = \frac{60}{20}$ 3 services per hour for each clerk

$\lambda/\mu = 5/3$

(i) $P_0 = \frac{1}{\left[\sum_{n=0}^{c-1} \frac{(\lambda/\mu)^n}{n!} + \frac{(\lambda/\mu)^c}{c!(1 - \frac{\lambda}{c\mu})} \right]}$

$$= \frac{1}{\left[1 + \frac{5}{3} + \frac{1}{2!} \left(\frac{5}{3} \right)^2 + \frac{1}{3!(1 - \frac{5}{3 \cdot 3})} \right]} = \frac{24}{139}$$

The expected number of idle clerks at any point of time

$$= 3P_0 + 2P_1 + 1P_2 = 3 \left(\frac{24}{139} \right) + 3 \cdot \frac{1}{3} \cdot \frac{5}{3} \cdot \frac{24}{139} + 1 \cdot \frac{1}{2!} \cdot \left(\frac{5}{3} \right)^2 \cdot \frac{24}{139} = \frac{4}{3} \text{ clerks}$$

Probability that one booking clerk will be idle = $\frac{4}{3} \times \frac{1}{3} = \frac{4}{9}$

Expected time a clerk spends with the clients, per week

$$= \left(1 - \frac{4}{9} \right) \times 4 \times 5 = 11.1 \text{ hours}$$

(ii) Average time a client spends in the bank,

$$W = \frac{\mu(\lambda - \mu)^c}{c! - 1(c\mu - \lambda)^c} P_0 + \frac{1}{\lambda} = \frac{3(5-3)^3}{2(3 \cdot 3 - 5)^3} \cdot \frac{24}{139} + \frac{1}{5} = 19.77 \text{ minutes.}$$

GAME THEORY

In our previous discussions, all references to decision making, whether under certainty or uncertainty, have been to decisions against nature. The basic assumption has been that the state of nature that occurs will be independent of the selection of strategy of the decision maker. In a different situation where the decision maker, before deciding upon his course of action, anticipates what action

his rational opponent (or competitor) having a conflicting interest will take, he is said to make *decision under conflict*. This aspect of decision theory is commonly known as *Game Theory*.

Game theory develops mathematical models which deal with the best possible strategies for a set of competitors (also called players) who need to beat each other in a competitive game. The competitors have conflicting interests and the outcome of the game is controlled by the combined decisions of all the competitors involved. The assumption in such a game is that each competitor will act in some rational manner and will make attempt to resolve the conflicting interests in his favour. As a normal prudent person, he will make honest attempt to win the game and not simply throw it away.

Conflicting situations arise in almost all the fields of life where game theory can be applied. We are, however, concerned here with business situations only where the main objective of each competitor is to maximise his profit or minimise his loss. For instance, the theory may be applied in a situation where a firm wants to decide upon the best strategy for a marketing plan for its product in face of the possible strategies of the other competitors in marketing the same product.

Two Person-Zero Sum Games. In two person-zero sum games, there are only two competitors whose interests are opposed in such a manner that the sum of the payoff (utilities) is zero, i.e. the gain of one is equal to the loss of the other. The other condition of the game is that the choices (of play or strategy) of each competitor are to be made simultaneously so that no competitor is aware of the choice of the opponent until he has committed to his own choice.

The matrix of a two person-zero sum game played by two competitors, A and B, may be described as follows :—

Strategy	B ₁	B ₂	.....	B _n
A ₁	a ₁₁	a ₁₂	.....	a _{1n}
A ₂	a ₂₁	a ₂₂	.....	a _{2n}
....
A _m	a _{m1}	a _{m2}	.....	a _{mn}

The above matrix actually represents the payoff for A. For the sake of brevity, B's matrix is omitted because it is just the opposite of A's payoff matrix. In the matrix for B, all the elements of A's matrix are to be transcribed (copied) with opposite signs (minus or plus, as the case may be), being the losses (profits) for the corresponding profits (losses) for A's strategies.

A two-person zero-sum game that can be solved by a simple method is the one where the payoff matrix contains a *saddle point* so that both the players can use their *pure strategies*. A saddle point is an element of the matrix that is the lowest element in its row but at the same time, the highest element in its column. In other words, saddle point is that element of a matrix that is the largest of the row minima as well as the smallest of the column maxima. In playing the game, player A uses his pure strategy corresponding to the row through the saddle point and player B uses his pure strategy corresponding to the column through the saddle point. Player A selects the *Minimax* and player B the *Maximin* criterion. The strategies

are pure strategies in the sense that each player has to stick to his only one selected strategy, if he has to maximise his profit or minimise his loss. The value of the game to A is the element at the saddle point and the value to B is its negative. Thus the profit or loss of both A and B are identical. A pure strategy game is illustrated below.

The following is the payoff matrix of a game. It is required to find the best strategy for each player, and the value of the game play for each of the two players.

		Player B				
Player A	Strategy	1	2	3	4	5
	1	4	6	9	3	2
	2	7	8	6	5	6
	3	3	9	6	4	8
	4	8	5	3	4	2

The first step in solving the game is to discover whether or not there is a saddle point. This is done by circling the minimum in each row and putting squares around the maximum in each column.

		Player B					
Player A	Strategy	1	2	3	4	5	Minimum
	1	4	6	<u>9</u>	3	<u>2</u>	2
	2	7	8	6	<u>5</u>	6	5
	3	<u>3</u>	<u>9</u>	6	4	<u>8</u>	3
	4	<u>8</u>	5	3	4	<u>2</u>	2
Maximum		8	9	9	5	8	

5/5 Minimax for A
or Maximin for B

The matrix has a saddle point of 5 in the second row and the fourth column. The pure strategy of Player A is strategy 1 and that of player B is Strategy 4. The value of the game is +5 to A and -5 to B. It may be noted that A will always stick to play 1 irrespective of the play of B and though B also becomes aware of it, he (B) will continue to play 4 because these are the only respective strategies that will maximise the gains of both A and B.

If the payoff matrix does not contain a saddle point, the players have to play mix strategies. Mixed strategies are not fixed strategies. A player B has the alternative to change his pure strategy as soon as he becomes aware of the opponent's (A's) pure strategy ; he has the alternative to play another of his own pure strategy so that he can have a higher gain. Again, when A comes to know of B's changed strategy, he also has the option to change to another of his own strategy if that gives him a higher gain. The process is continued so on. In contrast when a saddle point exists, both players maintain their own pure strategies because any change will not increase their gains.

Several methods are in use for solving games where mixed strategies are used. Basically, the solution of such games consists of evaluating the probabilities associated with each pure strategy used by either player. Three methods are discussed here.

(a) *Algebraic method* : This method may be used for solving a 2×2 (i.e., a two-person two-strategy) game. A two-person game is known as either '2n' or

'n2' game in which one player is limited to two strategies and the other player has n strategies ($n \geq 2$) to play ; 2n game refers to the one where the player having the columns has more than two strategies (player B in this text) and is the game where the player having rows (Player A) has more than one strategy. Similarly, a mn game will mean a two-person game where the players have m and n strategies respectively to play.

Let us consider the payoff matrix of a '2—2' game as follows :

		Player B		Minimum
		B ₁	B ₂	
Player A	A ₁	7	6	6
	A ₂	3	8	3
Maximum		7	8	

The matrix has no saddle point ; Minimax =6 and Maximin=7. The value of the game will, therefore, lie between 6 and 7.

Both the players will use their mixed strategies, i.e. each will play one pure strategy for some time and then the other pure strategy for some time. The selection of a strategy is associated with some probability which is to be determined for the evaluation of the game. Assuming ;

a_1 is the probability that A will use strategy A₁.

a_1 or $(1 - a_1)$ will be the probability that A will use strategy A₂.

Similarly b_1 and b_2 (or $1 - b_1$) are the probabilities that B will use strategies B₁ and B₂ respectively.

(For the sake of simplicity, we shall substitute a for a_1 and b for b_1 .)

If B selects B₁, A will select either A₁ or A₂, and

Expected value of payoff for A will be $= 7a + 3(1 - a)$

If B selects B₂,

Expected value of payoff for A will be $= 6a + 8(1 - a)$

The probability is such that under both the conditions, the payoffs are equal and, therefore,

$$7a + 3(1 - a) = 6a + 8(1 - a), \text{ or } a = 5/6$$

Thus A will play strategy A₁ for 5/6th of the time and strategy A₂ for 1/6th of the time.

If A selects A₁ for some time and A₂ for another some time,

Expected payoff for B will be,

For A₁ $= 7b + 6(1 - b)$, and for A₂ $= 3b + 8(1 - b)$

Therefore, $7b + 6(1 - b) = 3b + 8(1 - b)$, or $b = 1/3$

Thus B will play strategy B₁ for 1/3rd of the time and strategy B₂ for 2/3rd of the time.

The value of the game (V) = Expected profits to A when B uses B₁ \times Probability of B using B₁

plus

Expected profits to A when B uses B₂ \times Probability of B using B₂

$$= [7a + 3(1 - a)]b + [6a + 8(1 - a)](1 - b)$$

$$= 19/3 \text{ or } 6.33 \text{ (Substituting the values of } a \text{ and } b)$$

The plus value of the game indicates that on the average, A will win 6.33 per game.

For a 2—2 game with no saddle point, the game value may be obtained direct with the help of the following formulae :

$$\frac{a_1}{a_2} = \frac{a_{22} - a_{12}}{a_{11} - a_{12}}$$

$$\frac{b_1}{b_2} = \frac{a_{22} - a_{12}}{a_{11} - a_{12}}, \text{ and}$$

$$V = \frac{a_{11}a_{22} - a_{12}a_{21}}{a_{11} + a_{22} - (a_{12} + a_{21})}$$

With the data in the above illustration,

$$\frac{a_1}{a_2} = \frac{8-3}{7-6} = 5, \quad \therefore a_1 = 5/6 \text{ and } a_2 = 1/6$$

$$\frac{b_1}{b_2} = \frac{8-6}{7-3} = \frac{2}{4}, \quad \therefore b_1 = 1/3, b_2 = 2/3$$

$$V = \frac{7 \times 8 - 6 \times 3}{7 + 8 - (6 + 3)} = \frac{19}{3} = 6.33$$

(b) *Linear programming formulation method* : This method is suitable for solving two-person m-n game.

Refer to the payoff matrix in Page 970 :

Player A has m strategies, viz. A_1, A_2, \dots, A_m , and

Player B has n strategies, viz. B_1, B_2, \dots, B_n

If A selects A_i and B selects B_j , Payoff for A = a_{ij}

If the probabilities of A's plays are a_1, a_2, \dots, a_m , and
the probabilities of B's plays are b_1, b_2, \dots, b_n

$$\sum_{i=1}^m P_i = 1 \text{ and } \sum_{j=1}^n P_j = 1$$

Payoff to A = V

The linear programming problem will be defined as :

Determine a_1, a_2, \dots, P_n and V
to maximise V

Subject to, $a_{11}a_1 + a_{21}a_2 + \dots + a_{m1}a_m \geq V$

$$a_{12}a_1 + a_{22}a_2 + \dots + a_{m2}a_m \geq V$$

.....

$$a_{1n}a_1 + a_{2n}a_2 + \dots + a_{mn}a_m \geq V$$

$$a_1 + a_2 + \dots + a_m = 1$$

$$b_1 + b_2 + \dots + b_n = 1$$

$$a_1, a_2, \dots, a_m \geq 0, \text{ i.e. } a_i \geq 0, i = 1, 2, 3, \dots, m$$

$$b_1, b_2, \dots, b_m \geq 0, \text{ i.e. } b_j \geq 0, j = 1, 2, \dots, n$$

The above may be illustrated with a payoff matrix as follows :

		Player B		
		1	2	3
Player A	1	-1	2	1
	2	1	-2	2
	3	3	4	-3

The inequalities will be :

$$-a_1 + a_2 + 3a_3 \geq V$$

$$2a_1 - 2a_2 + 4a_3 \geq V$$

$$a_1 + 2a_2 - 3a_3 \geq V$$

$$-b_1 + 2b_2 + b_3 \leq V$$

$$b_1 - 2b_2 + 2b_3 \leq V$$

$$3b_1 + 4b_2 - 3b_3 \leq V$$

In addition,

$$\begin{aligned}a_1 + a_2 + a_3 &= 1 \\b_1 + b_2 + b_3 &= 1 \\a_1, a_2, a_3, b_1, b_2, b_3 &\geq 0\end{aligned}$$

The above problem, when solved algebraically or by Simplex method, will give the following solution :

$$\begin{aligned}a_1 &= 17/46 & b_1 &= 14/46 \\a_2 &= 20/46 & b_2 &= 12/46 & V &= 30/46 \\a_3 &= 9/46 & b_3 &= 20/46\end{aligned}$$

An important point to be noted in the solving of games whose payoff are of higher dimensions is to try to reduce the dimensionality of the game by eliminating the recessive pure strategies, retaining only the dominant ones. If a pure strategy i has a payoff greater than or equal to pure strategy j for each possible course of action of the opponent, strategy i is said to dominate strategy j ; i is dominant and j is recessive. The probability that a player will choose a recessive strategy in his optimal mixed strategy is zero. Therefore, for reducing the size of a payoff matrix, the rows (columns) of the recessive strategies can be eliminated without affecting the value of the game. If by the process of such elimination, a payoff matrix of a large dimension can be reduced to a 2—2 game, the problem can be solved by the algebraic method discussed at (a) above.

In the 3—3 matrix given below, it will be seen that for A, A_1 dominates A_2 because for any action by B, A cannot improve his gain by changing from A_1 to

	B_1	B_2	B_3
A_1	3	5	-3
A_2	-4	2	-5
A_3	5	-6	3

A_2 . Similarly for B, B_3 dominates B_1 . Row A_2 and column B_1 may, therefore, be eliminated to give a reduced matrix of 2—2 dimension, as follows :

	B_2	B_3
A_1	5	-3
A_3	-6	3

This can be solved algebraically (formulae on Page. 971) to give a game value of -0.18, i.e. a loss for A to that extent.

(c) *Graphical method* : The graphical method may be used for solving a 2—n or n—2 game. Let us consider the following game :

	B_1	B_2	B_3
A_1	1	3	11
A_2	8	5	2

The graph is plotted as shown in Fig. 19.18. The two strategies, A_1 and A_2 are indicated on the X axis which represents probabilities $a=0$ to $a=1$. The Y axis represents V, the pay off to A. (The graph may be extended below the X axis if there are negative elements in the payoff matrix.)

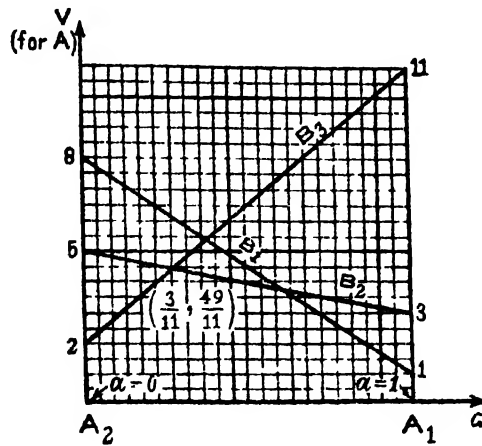


Fig. 19.18.

Each of the strategies, B_1 , B_2 and B_3 are plotted as indicated in the graph. The final solution to the game will be at one of the intersection points of the three lines that satisfies the conditions that, (i) it should have a V as great as possible and (ii) it must be below all the three lines. (No proof is given here.) In this graph, the point of intersection of B_2 and B_3 $(\frac{3}{11}, \frac{49}{11})$ satisfies both these conditions. Thus the probabilities of A_1 and A_2 being played are $\frac{3}{11}$ and $\frac{8}{11}$ respectively and the value of the game is gain to A of $\frac{49}{11}$. This may be also proved as follows :

$$3a + 5(1 - a) = 11a + 2(1 - a), \text{ or } a = \frac{3}{11}$$

$$\text{Value of game, } V = 3a + 5(1 - a) = 3 \cdot \frac{3}{11} + 5 \cdot \frac{8}{11} = \frac{49}{11}$$

Once V is known, the optimal strategies of B may be calculated algebraically, as follows :

$$V = 3b + 11(1 - b) \text{ [or } 5b + 2(1 - b)]$$

$$\text{or } 3b + 11(1 - b) = \frac{49}{11}, \text{ or } b = \frac{9}{11}$$

Therefore, strategies for B are $B_1 = \frac{9}{11}$, $B_2 = \frac{2}{11}$

REPLACEMENT MODELS

While the operating costs of an equipment including its maintenance costs gradually increase over time, its salvage value (or re-selling price) at different periods of time goes on decreasing. A replacement decision is, therefore, a trade off decision between the increasing operating costs and the decreasing salvage value and the replacement model determines the point of time when the average cost per year is minimised. In other words, the purpose of a replacement model is to determine the replacement age that minimises the total annual cost of the equipment.

Let us consider the following table in respect of an equipment purchased at a cost of Rs. 10,000 and whose life is 8 years :

Year	Operating costs	Cumulative operating costs	Salvage value	Capital cost (Purchase cost minus salvage value)	Total costs	Average cost per year
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1	800	800	5,000	5,000	5,800	5,800
2	1,000	1,800	2,500	7,500	9,300	4,650
3	1,300	3,100	1,000	9,000	12,100	4,033
4	1,800	4,900	500	9,500	14,400	3,600
5	2,400	7,300	500	9,500	16,800	3,360
6	3,400	10,700	200	9,800	20,500	3,417
7	4,000	14,700	200	9,800	24,500	3,500
8	5,000	19,700	200	9,800	29,500	3,687.5

(In the above table, operating costs and the salvage values in each year are predicted or assumed and the costs in the other columns are calculated with the assumed data.)

It is seen that the average annual cost decreases every year till the 5th year and thereafter, it starts increasing. The equipment should, therefore, be replaced at the end of the 5th year. The total annual costs each year are :

Year	Total annual costs	Year	Total annual costs
1	Rs. 5,800	5	Rs. 2,400
2	3,500	6	3,700
3	2,800	7	4,000
4	2,300	8	5,000

The above model is also useful for replacement decision making in cases where there are several identical equipments of different ages that are proposed to be replaced by equipments having a different efficiency, say an improved and better type of equipment. Let us assume that in the above example, one equipment aged 2 years and two equipments aged 3 years are to be replaced by two new model equipments costing Rs. 16,000 each and each having an efficiency 50% greater than the old equipments. It is further assumed that the replacement of 3 old equipments with 2 new equipments will not in any way affect the production or service schedule. The data in respect of the new model are given in the following table :

Year	Operating costs	Cumulative operating costs	Salvage value	Capital cost (Purchase cost minus salvage value)	Total costs	Average cost per year
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1	1,000	1,000	8,000	8,000	9,000	9,000
2	1,200	2,200	6,000	10,000	12,200	6,100
3	1,500	3,700	4,000	12,000	15,700	5,233
4	2,000	5,700	2,000	14,000	19,700	4,925
5	2,600	8,300	1,000	15,000	23,300	4,660
6	4,100	12,400	200	15,800	28,200	4,700
7	5,600	18,000	200	15,800	33,800	4,829
8	7,200	25,200	200	15,800	41,000	5,125

It will be seen that the lowest average annual cost is achieved if the equipment is replaced every 5 years. The minimum average annual cost is Rs. 4,660 which is equivalent to Rs. 3,107 ($\text{Rs. } 4,660 \times \frac{2}{3}$) in terms of one old-model equipment. Since this is less than the minimum average annual cost in respect of an equipment, viz. Rs. 3,360, the decision will be to replace the old model with the new-model equipment. The time of replacement will be determined as follows :

The total annual costs for the next and subsequent years for the three old equipments proposed to be replaced are,

Next year (1) Rs. 2,300 \times 2 + Rs. 2,800	- Rs. 7,400
(2) Rs. 2,400 \times 2 + Rs. 2,300	Rs. 7,100
(3) Rs. 3,700 \times 2 + Rs. 2,400	Rs. 9,800
(4) Rs. 4,000 \times 2 + Rs. 3,700	Rs. 11,700

The average annual cost for two new-model equipments will be Rs. 9,320 ($\text{Rs. } 4,660 \times 2$) and this will be exceeded by the average annual costs of the three old equipments only in year (3). Thus all the three old-model equipments should be replaced two years from now.

Replacement Models with Time Factor. In the preceding paragraphs, a very simple analysis has been made for the purpose of illustrating the basic procedures involved in building replacement models. No such model will, however, be practical unless the amounts of expenditure incurred in future periods are discounted to their present values. The average annual costs are, therefore, to be compared after including the element of interest in the calculations.

Let C be the purchase price of a machine, E_n , its operating cost in years n and i , the rate of interest. If it is assumed that the machine will be replaced after r years and that the expenditure is incurred at the beginning of every year (or the expenditure incurred during the year is discounted to the beginning of the year), the present value of the expenditure P_r , will be :

$$P_r = C + E_1 + \frac{E_2}{1+i} + \frac{E_3}{(1+i)^2} + \dots + \frac{E_r}{(1+i)^{r-1}}$$

(Compare this with the formula on Page 805 which assumes that the cash flow occurs at the end of the year.)

$$\text{or } P_r = C + E_1 + vF_2 + v^2E_3 + \dots + v^{r-1}E_r,$$

if $v, v^2, v^3, \dots, v^{r-1}$ represent $\frac{1}{1+i}, \frac{1}{(1+i)^2}, \frac{1}{(1+i)^3}, \dots, \frac{1}{(1+i)^{r-1}}$ respectively.

If replacement is made after $(r+1)$ years, P_{r+1} will be greater than P_r but in return for the extra expenditure, we get one year's extra service from the machine. The problem, therefore, is to find out some method to determine whether the extra service would be worth the extra expenditure incurred. For this purpose, let us convert the variable payments, F_1, E_2 etc. into fixed annual payments, E . We know that the present value, P_r , of fixed annual payments, E , for r years is denoted by the formula :

$$P_r = E + \frac{E}{1+i} + \frac{E}{(1+i)^2} + \dots + \frac{E}{(1+i)^{r-1}}$$

(Here also, compare this with the formulae on Pages 805 and 811 which relate to the cash flow at the end of the year.)

$$\text{Or } P_r = \frac{E(1-v^r)}{1-v} \text{ where } v \text{ denotes the discounting factor, as above.}$$

$$\therefore E = P_r \left(\frac{1-v}{1-v^r} \right)$$

it is advantageous to replace all items at a time at fixed intervals. This method of replacement, known as *Group replacement*, is particularly useful when the value of each individual item of the group is so small that it may not be worth while incurring expenditure on keeping records of individual ages.

The example given below illustrates both the types of replacement model in 'work or completely fail' situations.

EXAMPLE 19.14.

A decorative series lamp set circuit contains 10,000 bulbs. When any bulb fails, it is replaced. The cost of replacing a bulb individually is Re 1. If all the bulbs are replaced at the same time, the cost per bulb would reduce to 35 paise. The percent serving, $S(t)$, at the end of month (t) are :

(t)	0	1	2	3	4	5	6
$S(t)$	100	97	90	70	30	15	0

What is the optimum replacement plan ?

(I.C.W.A.—Adapted)

ANSWER :

The percent failing, $S(t)$, at the end of month (t) and the probability of failure, $P(t)$ during month (t) are :

(t)	0	1	2	3	4	5	6
$S(t)$	0	3	10	30	70	85	100
$P(t)$	0	0.03	0.07	0.20	0.40	0.15	0.15
			$\left(\frac{10-3}{100}\right)$	$\left(\frac{30-10}{100}\right)$	$\left(\frac{70-30}{100}\right)$	$\left(\frac{85-70}{100}\right)$	$\left(\frac{100-85}{100}\right)$

It will be seen from the above that no bulb survives for more than 6 months. A bulb surviving upto the 5th month is sure to fail during the 6th month.

If N_i denotes the number of bulbs replaced at the end of i th month, $N_0 = 10,000$

$$N_1 = N_0 P_1 = 10,000 \times 0.03 = 300$$

$$N_2 = N_0 P_2 + N_1 P_1 = 10,000 \times 0.07 + 300 \times 0.03 = 709$$

$$N_3 = N_0 P_3 + N_1 P_2 + N_2 P_1 = 10,000 \times 0.20 + 300 \times 0.07 + 709 \times 0.03 = 2,042$$

$$N_4 = N_0 P_4 + N_1 P_3 + N_2 P_2 + N_3 P_1$$

$$= 10,000 \times 0.40 + 300 \times 0.20 + 709 \times 0.07 + 2,042 \times 0.03 = 4,171$$

$$N_5 = N_0 P_5 + N_1 P_4 + N_2 P_3 + N_3 P_2 + N_4 P_1$$

$$= 10,000 \times 0.15 + 300 \times 0.40 + 709 \times 0.20 + 2,042 \times 0.07 + 4,171 \times 0.03 = 2,030$$

$$N_6 = N_0 P_6 + N_1 P_5 + N_2 P_4 + N_3 P_3 + N_4 P_2 + N_5 P_1$$

$$= 10,000 \times 0.15 + 300 \times 0.15 + 709 \times 0.40 + 2,042 \times 0.20 + 4,171 \times 0.07 + 2,030 \times 0.03 = 2,590$$

It will be seen from the above that N_i increases upto the 4th month and then decreases. The value of N_i oscillates till the system acquires a steady state. In the steady state, the proportion of bulbs failing each month is the reciprocal of the average life.

$$\text{Expected average life} = \frac{1P_1 + 2P_2 + 3P_3 + 4P_4 + 5P_5 + 6P_6}{0.03 + 0.14 + 0.60 + 1.60 + 0.75 + 0.90} = 4.02$$

Therefore, in the steady state, the number of failures (i.e. the number requiring replacement) per month = $10,000/4.02 = 2,487.56$, i.e. 2,488 bulbs, the cost of which will be Re 1 × 2,488 = Rs. 2,488.

Under the Group Replacement Plan, the position will be as follows :—

End of the month	Total cost of group replacement	Cost per month Rs.
	(Individual Re. 1 + Group Re. 0.35)	
1	$300 \times 1 + 10,000 \times 0.35 = 3,800$	3,800
2	$300 + 709 + 3,500 = 4,509$	2,254.50
3	$300 + 709 + 2,042 + 3,500 = 6,551$	2,183.66
4	$300 + 709 + 2,042 + 4,171 + 3,500 = 10,722$	2,680.50
5	$300 + 709 + 2,042 + 4,171 + 2,030 + 3,500 = 12,752$	2,550.40
6	$300 + 709 + 2,042 + 4,171 + 2,030 + 2,590 + 3,500 = 15,342$	2,557.00

Group replacement should be made after 3 months and the average cost per month will be Rs. 2,183.66.

SIMULATION

Despite the evolution of numerous sophisticated mathematical models for solving managerial decision making problems, it is seen that a number of complex problems arise which are beyond solution through the mathematical techniques known so far. In such situations, the quantitative process known as simulation (literally meaning ; feigning, pretending, to be or acting like) is applied as an appropriate substitute for mathematical development of a model. The technique consists of developing a simulated model of a problem or a process under real life situation by drawing representative samples and then conducting a series of methodical experiments on trial and error basis in order to examine the effects of the various parameters which define the process and to predict the behaviour of the process over time.

The basic steps in the procedure of simulation are :

- (i) Identification of the problem.
- (ii) Construction of a model of the given problem.
- (iii) Testing the model to ensure that its behaviour conforms to the behaviour of the actual problem under real situation.
- (iv) Identifying and collecting data, i.e. supplying values for input parameters and measuring the output values, needed to test the values.
- (v) Running the simulation process.
- (vi) Making changes, if required, in the model or parameters.
- (vii) Re-running the solution to test new solution.

The Need for Simulation. The use of simulation becomes essential in solving managerial problems in situations where, (i) development of a mathematical model is not possible, (ii) making observations in a real situation is quite expensive and sometimes, very difficult, (iii) making observations on a long-term basis (e.g. the study of the trend of population growth over time) requires too much time, and (iv) operating more than one set of real situation, all at a time, for the purpose of observing the alternative data, is not feasible.

Simulation is widely used for diverse applications. Assisted by the computer, the simulation procedure can handle a variety of problems that need numerous observations to be collected and studied.

Monte Carlo Methods of Simulation. A typical Monte Carlo simulation procedure replaces the actual universe of items by a theoretical universe described by some assumed probability distribution and then drawing samples from this theoretical population by means of random numbers. Random numbers are available from tables but in practice, where simulation is run on a computer, the random numbers are generated through the computer programme itself. The random number (which, in essence, is a random observation in the range 0 to 1 drawn from a standard uniform distribution) is transformed into an observation from the probability distribution which defines the variable element in the problem. This probability distribution may be one of the standard distributions, such as Normal, Poisson etc. or it may be of an empirical nature, derived from a sample data for the variable concerned. While there are standard procedures for transforming the random numbers in the former situation, the transformation in the latter case is made by collecting data over a period of time. The basic procedure of simulation will be clear from the simplified illustration given in the next page.

The following standard data in respect of the introduction of a new product are assumed :

Selling price	Rs. 4 per unit
Variable cost	Rs. 2 per unit
Contribution	Rs. 2 per unit
Sales volume	30,000 units per period
Total Contribution	Rs. 60,000
Investment cost	Rs. 15,000
Profit	Rs. 45,000

The possibility estimates for selling price, variable cost and sales volume are as follows :

Selling price		Variable cost		Sales volume	
Value Rs.	Probability	Value Rs.	Probability	Value units	Probability
3.00	.1	1.25	.1	25,000	.1
3.50	.2	1.50	.2	28,000	.1
4.00	.5	2.00	.4	30,000	.6
4.50	.2	2.25	.2	35,000	.2
		2.50	.1		

If we select two-digit random numbers (00—99) for simulating the above distributions, the ranges of random numbers assigned to each will be as follows :

Selling price			Variable cost			Sales volume		
Value	Cumulative Probability	Random Numbers	Value	Cumulative Probability	Random Numbers	Value	Cumulative Probability	Random Numbers
3.00	.1	00-10	1.25	.1	00-10	25,000	.1	00-10
3.50	.3	11-30	1.50	.3	11-30	28,000	.2	11-20
4.00	.8	31-80	2.00	.7	31-70	30,000	.8	21-80
4.50	1.0	81-100	2.25	.9	71-90	35,000	1.0	81-100
			2.50	1.0	91-100			

To simulate, we take 10 trials, the results of which are shown in the table below. (In a real situation, thousands of such trials will be required to be made.) The random numbers have been obtained from tables.

Simulation for introducing a new product

Observation No.	Selling price		Variable cost		Contribution (Rs.)	Sales volume		Total contribution (Rs.)	Profit (Rs.)
	Random number	Value (Rs.)	Random number	Value (Rs.)		Random number	Value (units)		
1	95	4.50	11	1.50	3.00	1	28,000	84,000	69,000
2	92	4.50	91	2.50	2.00	22	30,000	60,000	45,000
3	67	4.00	99	2.50	1.50	63	30,000	45,000	30,000
4	24	3.50	57	2.00	1.50	63	30,000	45,000	30,000
5	76	4.00	26	1.50	2.50	23	30,000	75,000	60,000
6	64	4.00	61	2.00	2.00	18	28,000	56,000	41,000
7	02	3.00	70	2.00	1.00	32	30,000	30,000	15,000
8	53	4.00	33	2.00	2.00	21	30,000	60,000	45,000
9	16	3.50	91	2.50	1.00	13	28,000	28,000	13,000
10	16	3.50	67	2.00	1.50	06	25,000	37,500	22,500

Total Profit = Rs. 3,70,500
Average Profit = Rs. 37,050

Carrying cost = 99.5×0.2	= £19.90
Ordering cost = $3 \times £5$	= £15
Total cost	= £34.90

- Notes :**
1. It is assumed that the ordered quantity is received on the 3rd day, excluding the day of order. If 3 clear days are assumed, the order quantity will be received on the 4th day and the calculations will be different.
 2. There is no stock out on any day so that there are no lost sales. With the second assumption at 1 above, lost sales will occur.
 3. In the problem given, lead time is taken to be constant. If otherwise, simulation of lead time distribution would also have been required.

PROGRAMME EVALUATION AND REVIEW TECHNIQUE (PERT) AND CRITICAL PATH METHOD

Prior to the introduction of Network Analysis through PERT and CPM, Gantt Bar Chart was one of the techniques used for scheduling the various activities of a large project. The Gantt Chart is a special type of bar chart in which bars are placed horizontally. This chart shows both the plan and the accomplishment of the plan and is used for indicating plant utilisation and production planning. A Gantt Chart showing planned and actual machine loading is given in Fig. 19.19. The thick lines in the chart indicate the planned load and the thin lines show the actual load on the machine. The Gantt Chart is, however, not capable of indicating the inter-relationship between various activities, particularly of large and complex projects and although the chart may be modified to some extent by building in it a network of activities, its application is limited. The PERT network that evolved from the Gantt Chart is now widely used to meet the situation.

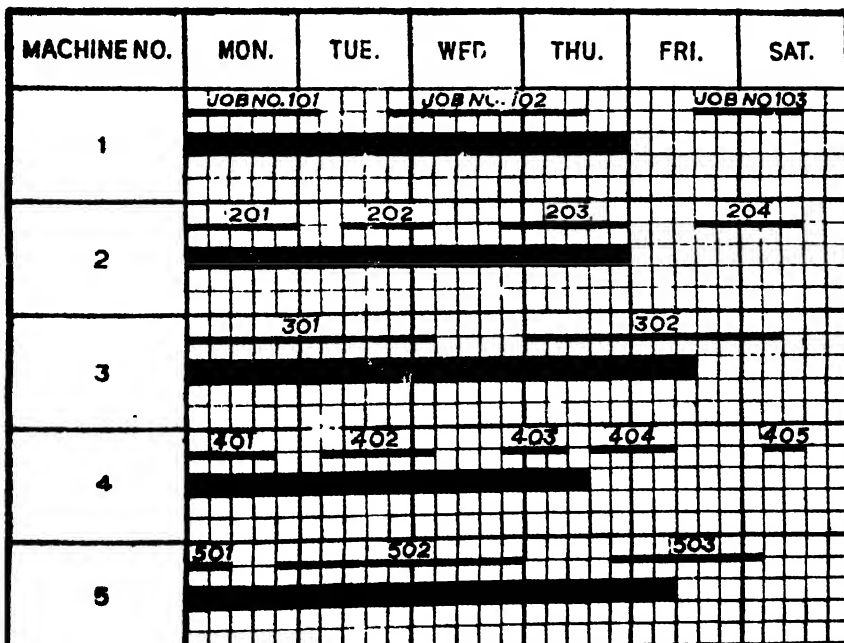


Fig. 19.19. Gantt Chart

PERT, which is an acronym for *Programme Evaluation and Review Technique* was first developed in the U.S.A. for the planning and development of the Polaris ballastic missile. Though originally a technique for planning and scheduling, meant to accelerate the missile development for war purposes, PERT has now found extensive civilian use and has proved to be a powerful tool for the management of programmes. For example, in the programming of a large contract or project, PERT finds out the inter-relationship between the various phases of the contract work or the project which consists of a large number of activities and determines the expected time required to complete those activities leading up to an event, i.e. up to a certain stage of completion of work. When a project programme is difficult to schedule or is required to be frequently revised, PERT provides the essential tool for control of programme revisions and re-appropriation of funds.

CPM or Critical Path Method is another technique closely allied to PERT. Though the methodology of CPM is, to a large extent similar to that for PERT, the two techniques were developed independent of each other and their objectives are, by and large, different. We will discuss these differences at a later stage. CPM introduces the concept of critical path, i.e. the longest time required to complete a project and emphasises the reduction of the duration of the activities by the application of more resources by obtaining a trade off between cost and time of completion.

The fundamental in PERT approach is to design a network. A network (also known as project graph or arrow diagram) is a sort of master chart covering the entire programme ; it shows the events and activities arranged in the order in which they occur. Network sets out to control the project by establishing dates for each event to happen. For this purpose, a project is broken up into its various component jobs or activities and events are connected by the activities. An *event* is a satisfied accomplishment in the programme, i.e. the completion of a component task or job. An *activity* is the actual performance of a task and is represented as the time link between related events. A chain of sequential events and activities, from the starting point of a project to its completion, constitutes a network path.

Building the Network. A sample network diagram is illustrated in Fig. 19.20. We will see, step by step, how this network is built up. The project illustrated consists of 8 events (nodes, junctions, milestones or stays), i.e. 1, 2, 3, 8, denoted by circles and 11 activities, i.e. a, b, c, k (or 1-2, 1-3, 1-4 etc.) denoted by arrows which connect the events. The network diagram takes care of the sequences and the inter-relationship between the activities but the length of the arrows joining two activities has no relevance to the time taken for completing the activity. The significant point to be observed is that the immediately preceding event and the immediately succeeding event of each activity should be properly laid out. The main rule is that before any activity leaving an event can be taken in hand, all the activities entering that event must be completed. Before building the diagram, it is essential to list out all the activities and identify the immediate predecessor activities for each activity as shown in the next page.

Activity or job identification	Immediate predecessors	Time to perform activity (days)
a(1—2)	—	2
b(1—3)	—	3
c(1—4)	—	2
d(2—5)	a	8
e(2—6)	a	5
f(3—6)	b	7
g(3—7)	b	2
h(4—7)	c	6
i(5—8)	d	2
j(6—8)	e, f	4
k(7—8)	g, h	5

Activities are of two types, viz real and dummy activities. *Real activities* are the necessary operations carried out to progress the project from one event to another. Real activities need time, money, manpower and/or equipments. *Dummy activities* do not involve any actual operation or work but they are

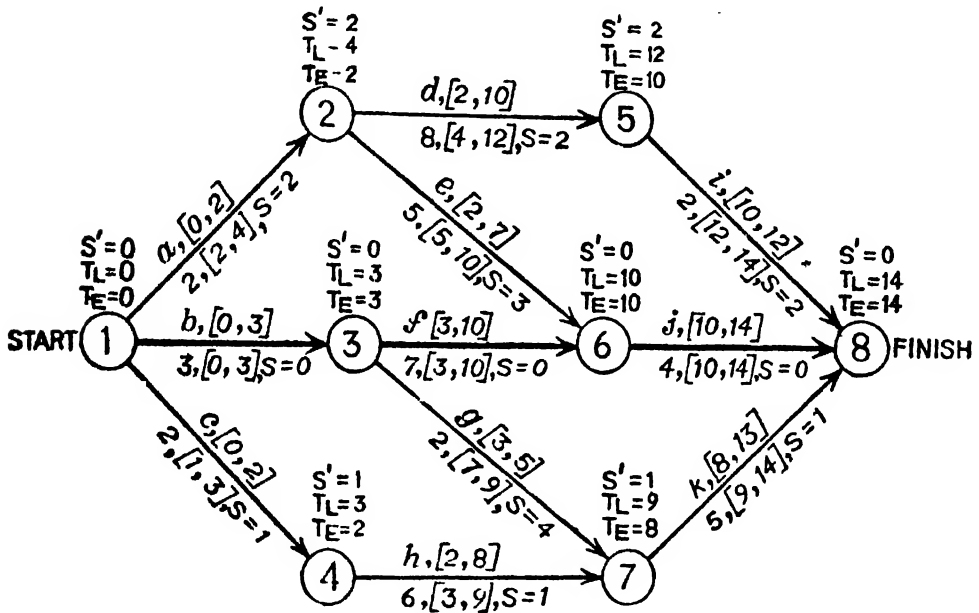


Fig. 19 20 Sample Network Diagram

constraints which show the dependance of one event upon another event. It is always possible to start simultaneously several activities emanating from a single event or to complete simultaneously several activities terminating into a single event. In such cases, dummy activities are inserted in the network diagram to suitably connect the events. Dummy activities usually have zero time but sometimes lead time or waiting time is involved, e.g. in the case of time gap between purchase order release and receipt of materials or drying, curing or setting time needed before the next process or operation can be started. Dummy activities, represented by dotted lines, may be seen in the figures in Examples 19.17 and 19.18. Dummies are also often inserted merely to improve the layout of a network diagram by avoiding 'curved' activity lines. This would be necessary when a number of activities either start from a point or converge to a particular point,

The diagram illustrated above is an *activity-oriented* network most commonly used for CPM and it needs less storage space in mechanisation. The other type is event-oriented network used for PERT and for presentation to the management since it is simple to understand. A severe limitation of event-oriented network is that the numbering of the nodes does not automatically identify the preceding and succeeding activities.

Activity Times and Float or Slack. The time to be shown against each activity is the time estimated for completion of that activity. This may be in days, weeks, months etc. By summing the activity times along a path leading to an event, the expected completion date for that event can be established. Only one time estimate is made in the CPM network as the CPM technique is used mainly in building construction and industrial production work where the time for an activity can be established with relative certainty. PERT, however, was developed for research and development programme in which there is an element of uncertainty. For PERT network, therefore, three time-estimates, viz. optimistic, most likely and pessimistic times are made for each activity. It is assumed that activity time follows β (beta) distribution. Mean time is worked out as $(a + 4c + b)/6$, where a is the optimistic time, i.e. an estimate of the minimum time an activity will take, b is the pessimistic time estimate, i.e. the estimate of the maximum time the activity will take and c is the most likely time estimate, i.e. an estimate of the normal time that an activity will take more frequently.

Standard deviation for the activity time is given by,

$$\sigma = \frac{b - a}{6}, \text{ and variance } \sigma^2$$

$$\text{Thus if } a = 4, b = 16 \text{ and } c = 7, \text{ mean time} = \frac{4 + 4 \times 7 + 16}{6} = 8$$

$$\sigma = \frac{16 - 4}{6} = 2, \quad \sigma^2 = 4$$

It will be seen that the network diagram under discussion has 5 different paths leading from event 1 (start) to event 8 (finish). The time taken from start to finish through these paths are as follows :

Path	Time
a, d, i	$2 + 8 + 2 = 12$ days
a, e, j	$2 + 5 + 4 = 11$ days
b, f, j	$3 + 7 + 4 = 14$ days
b, g, k	$3 + 2 + 5 = 10$ days
c, h, k	$2 + 6 + 5 = 13$ days

The longest path (here, b f j, which takes 14 days) is called the *most critical path* because it is this path which establishes the time constraint over the completion of the project. The sum of the activity times on this path determines the date on which the project is expected to be completed. Attention has to be given to this path as any increase in the time of any activity on this path will delay the completion of the project and in case the completion date is required to be advanced, reduction in the time of the activities on the critical path has to be considered. There may

be more than one critical path in a diagram (i.e. more than one path may have identical highest aggregate time for all the activities) and sometimes, the reduction in the time of an activity on the critical path may make that path non-critical so that some other path in the net work may become critical. It also follows that non-critical paths have some *slack* or *float*, as they are called, relative to the critical activities. Normally slacks are used for events and floats for activities. The float in a path or in an activity, which is a sort of cushion time, is an indication of flexibility and calculation of the float in the various paths of a network is useful for proper scheduling of the activities. In order to calculate slack in an activity or an event, it is necessary to estimate its Early Start and Early Finish times and Late Start and Late Finish times.

The *early start* time of an activity in a project is the earliest possible time that the activity can begin and the *early finish time* of an activity is its early start time plus the time needed to complete that activity. In Fig. 19.20, the early start and early finish times for each activity have been indicated in the parenthesis above the activity line. Thus, the early start time for activity *a* is 0 and its early finish time is $0 + 2 = 2$; the corresponding times for *d* are 2 (*d* can start at the earliest only after *a* has been completed, i.e. after two days) and 10 (i.e. $2 + 8$). This is known as *Forward Pass*.

While the early start and early finish times are determined by starting at the beginning of the network, late start and late finish times are calculated by working backwards starting from the end of the network (*backward pass*). *Late start time* of an activity is the latest time it can begin without pushing the finish date of the project beyond the stipulated date. The *late finish time* of an activity is its late start time plus its activity time. In the diagram, these are indicated in the parenthesis below the activity line. For example, the late finish and late start times for *k* are 14 and 9 (i.e. $14 - 5$), respectively and so on for the other activities.

The difference between the late start and early start times (which is identical with the difference between late finish and early finish times) is the *total float* or *total slack* for that activity (denoted by 'S' in the diagram). For activity *a*, total slack is $2(2 - 0$ or $4 - 2)$; for *b*, it is $0(0 - 0$ or $3 - 3)$ and so on. It should be noted that the activities on the critical path have zero total float. An activity can be relaxed or delayed to the extent of its available total float without affecting the date of completion of the project. However, if the start of an activity which is not on the critical path is delayed, the starting of the subsequent activity would be delayed; the use of the total float of an activity by delaying it will, in most cases, affect (i.e. reduce or eliminate) the total float of the succeeding activities.

There is another type of float, known as *free float*. Free float or free slack is the period of time up to which an activity can be delayed without affecting the early start time of any other activity. Free float occurs when there are two or more activities leading into a single event and the activity has more float than one of its immediate successors. Free float is calculated as the difference between the early finish time of the activity and the earliest of the early start time of all its immediate successors. Free float for an activity may also be calculated as the difference between its total float and the minimum total float of all its immediate

successors. We find in Fig. 19.20 that k cannot start till the lapse of 6 days from the start of h . Activity g , which is also an immediate predecessor to k takes only 2 days for completion and thus it can afford to start $6-2=4$ days late without affecting the starting time for k . Thus g has a free float of 4 days. Similarly, e has a free float of $7-5=2$ days.

Since complex networks require the use of computer, critical path algorithms are written in the form of a linear programming problem suitable for a computer. If,

activity is denoted by $i-j$,

earliest time of completion for $i-j$ by x_j , and

duration of activity by t_{ij} ($i = 1, 2, 3, \dots, m$),

the total duration of the project will be, $x_m - x_1$. The linear programming problems will be expressed as follows :—

Minimise $x_m - x_1$, subject to the constraints, $x_j - x_i \geq t_{ij}$, for all ij .

The formulation for the sample network in Fig. 19.20, will be as follows :—

Minimise $x_8 - x_1$, subject to

$$\begin{array}{ll} x_2 - x_1 \geq 2 & x_6 - x_1 \geq 7 \\ x_3 - x_1 \geq 3 & x_7 - x_4 \geq 6 \\ x_4 - x_1 \geq 2 & x_8 - x_6 \geq 4 \\ x_5 - x_2 \geq 8 & \end{array}$$

The above may be solved by the Simplex method as a primal problem in the usual manner or by converting it into a dual model. The solution will be, $x_1 = 0$, $x_2 = 2$, $x_3 = 3$, $x_4 = 2$, $x_5 = 10$, $x_6 = 10$, $x_7 = 8$ and $x_8 = 14$ so that earliest time of completion of the project is $x_8 - x_1 = 14$ days.

As stated earlier, statistical methods are used for determining uncertainty in project time, particularly in PERT technique which is used mostly for new projects where historical data are not available. The application of such methods will be clear from the answer to the problem in the following example.

EXAMPLE 19.16.

A small project is composed of 7 activities whose time estimates are listed in the table below. Activities are identified by their beginning (i) and ending (j) node numbers.

Activity i—j	Estimated Duration (in weeks)		
	Optimistic	Most likely	Pessimistic
1—2	1	1	7
1—3	1	4	7
1—4	2	2	8
2—5	1	1	1
3—5	2	5	14
4—6	2	5	8
5—6	3	6	15

- Draw the project network and identify all the paths through it.
- Find the expected duration and variance of each activity. What is the expected project length?
- Calculate the variance and standard deviation of the project length. What is the probability that the project will be completed :
 - at least four weeks earlier than the expected time ;
 - no more than four weeks later than the expected time.

(d) If the project due date is 19 weeks, what is the probability of not meeting the due date ?

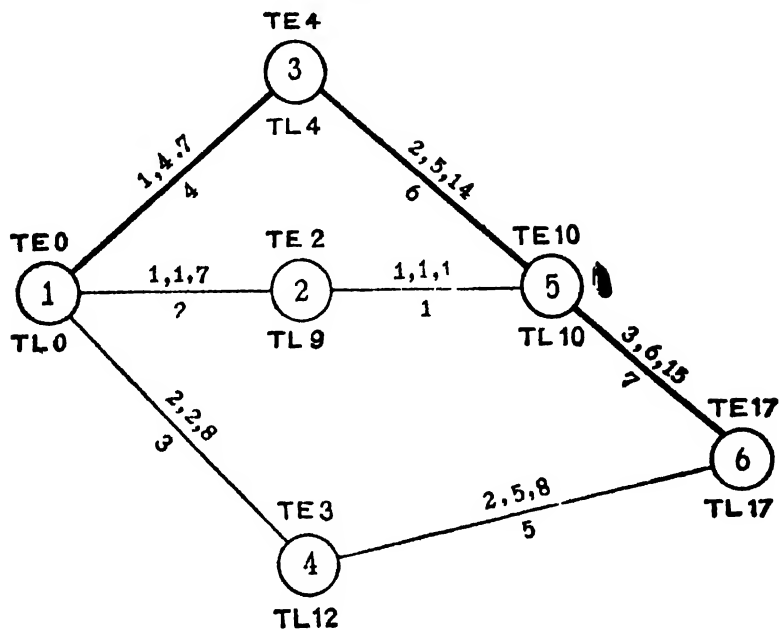
Given :

Z	0.50	0.67	1.00	1.33	2.00
P	0.3085	0.2514	0.1587	0.0918	0.0228

(I. C. W. A., Final)

ANSWER :

(a) The network is drawn as shown below :



The paths are :

1	1 - 3 - 5 - 6	time 4 + 6 + 7 = 17 weeks (Critical Path)
2	1 - 2 - 5 - 6	2 + 1 + 7 = 10 weeks
3	1 - 4 - 6	3 + 5 = 8 weeks

(b) Expected duration and variance of the various activities are computed as follows :—

Activity	Expected duration	Variance
	$t_e = \frac{t_o + 4t_m + t_p}{6}$	$\left[\frac{t_p - t_o}{6} \right]^2$
1 - 2	$\frac{1 + 4 \times 1 + 7}{6} = 2$	$\left[\frac{7 - 1}{6} \right]^2 = 1$
1 - 3	4	1 (on critical path)
1 - 4	3	1
2 - 5	1	0
3 - 5	6	4 (on critical path)
4 - 6	5	1
5 - 6	7	4 (on critical path)

Expected project length is 17 weeks

(c) Variance of critical path = $1 + 4 + 4 = 9$ weeks

Standard deviation, $\sigma = \sqrt{9} = 3$ weeks

$$(i) Z = \frac{X - \mu}{\sigma} = \frac{T - T_{exp}}{\sigma} \quad [\text{Refer to Page 914}]$$

$$\text{When } T - T_{exp} = -4, \quad Z = \frac{-4}{3} = -1.33$$

\therefore Probability = $1 - 0.9082$ (by symmetry)
= 0.0918 or 9.18%

$$(ii) \text{ When } T - T_{exp} = 4, \quad Z = \frac{4}{3} = 1.33$$

\therefore Probability = 0.9082 or 90.82%

(d) When project due date (T) is 19 weeks,

$$Z = \frac{19 - 17}{3} = \frac{2}{3} \text{ or } 0.67$$

Probability of meeting due date = 0.7486 or 74.86%

\therefore Probability of not meeting due date = $100 - 74.86 = 25.14\%$

Project Costs and the Network. So far we have discussed PERT and CPM as time scheduling techniques. In fact, this was the sole objective when PERT and CPM were originally developed. Both these network techniques have since been extended for use as techniques of cost control. In network cost systems, costs are controlled on project basis and not according to the functional organisation of a concern. So far as the network is concerned, the individual activities or group of activities (also known as work package) and not the various departments and divisions of the concern constitute the cost centres for cost accounting and cost control. Costs are budgeted and the actuals recorded according to the activities in the network. For control purposes, the actuals are compared with the budgets for an activity after adjusting the latter to account for the percentage of work of the activity completed. If, for example, 60% of an activity has been completed, the total budget for the activity should be brought down to 60% and then compared with the actual cost incurred. We will revert to this subject later in another section of this chapter.

Cost associated with the activities of a project are of two types, viz. direct cost of the individual activities and indirect cost relating to control or direction of work. Direct costs include expenditure on labour, materials, equipment, machineries, land etc., design and engineering charges, erection charges, payment to sub-contractors, etc. Indirect costs consist of two parts; the variable indirect costs which vary more or less directly with time or the volume of work like managerial services, supervision charges, rent of equipments, interest on capital, etc. and the fixed indirect costs which are to be met independent of the progress of the work such as licence fees, royalties, initial expenses, etc.

Activity time can be reduced if more men, machines, money and other resources are brought in and so direct costs increase if the activities are expedited or crashed. For example, crashing may be done by employing more men, paying overtime, sub-contracting at additional cost or improving quality of material (say, for example, the use of quicker drying cement or paint so that the next activity can be taken up earlier). The relationship between direct cost and activity duration is shown graphically in Fig. 19.21. The slope of time-cost trade off line indicates

the rate of increase of cost as we proceed (or rather move backwards) from the normal time to the crash time for the activity. Mathematically, the slope (assuming that cost varies linearly with time) is determined as,

$$\frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$$

If crash cost and normal cost be Rs. 400 and Rs. 300 respectively and normal time and crash time be 10 days and 8 days respectively, the slope will be, $(400 - 300) / (10 - 8) = 50$. The crash time limit indicates that the duration cannot be reduced further.

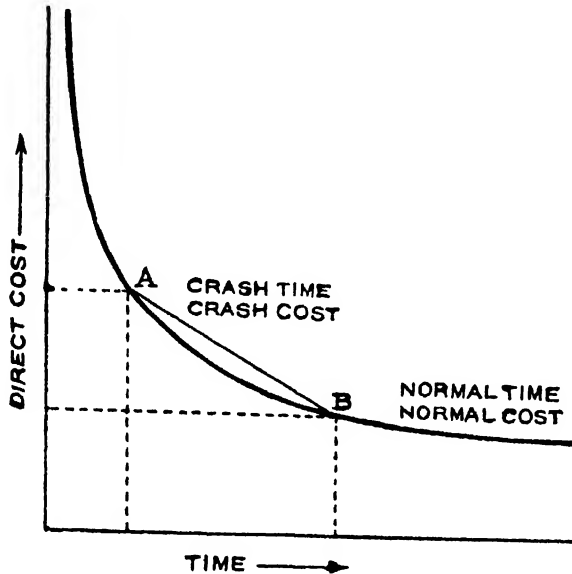


Fig. 19.21. Direct project Cost

It is obvious that the activities on the critical path only are considered for crashing. If an activity has a slack, it should be completed in normal time, i.e. the time ordinarily estimated for it so that less resources are used.

Indirect cost, on the other hand, increases as the time for an activity increases; the longer the duration of the activity, the higher will be the indirect costs. For each activity, therefore, there is an optimum point where the sum of the related direct cost and indirect cost is the minimum (see Fig. 19.22).

Crash time is the minimum time in which the job or activity can be performed irrespective of cost, whereas normal time is the time in which the job can be performed at a minimum cost. In a crashing programme, the activity on a critical path that can be crashed with the least increase in cost (i.e. the activity that has the least time-cost slope) is examined first. The cost of reducing its time, in gradual steps taking one unit period (say, one day) at a time, is matched against the corresponding savings achieved, till the optimum point where a further reduction would not pay off is reached. The other critical activities are taken up in a similar manner, one by one, in the order of their least steepness in the time cost graph till no further reduction in the time of any activity is feasible.

A few examples are given here to illustrate the methods explained in the foregoing sections.

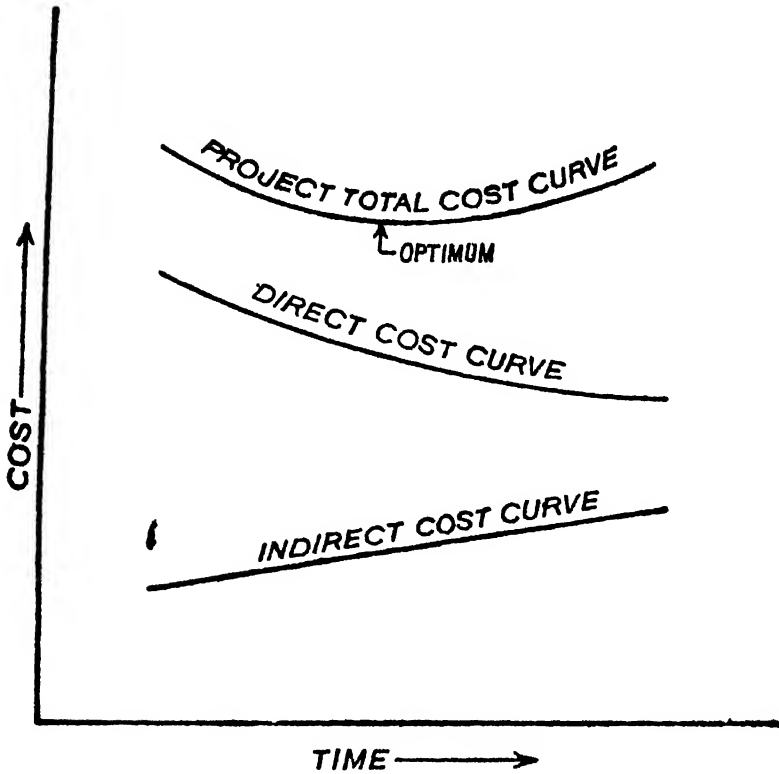
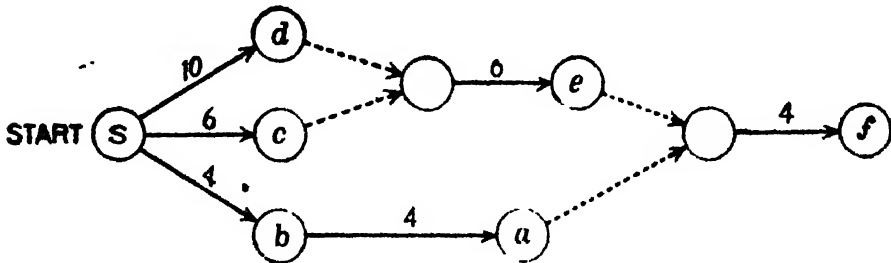


Fig. 19.22. Time cost trade off.

EXAMPLE 19.17.

A project is represented below. The numbers given are the normal expected completion time in days of the activities.



You are required to :

- Compute the earliest expected starting time and the earliest expected finishing time for each activity ;
- Indicate the critical path ;
- State the total cost if each separate activity costs Rs. 200 per day, and there is a further charge of Rs. 500 for every day the project is in progress ;
- State :
 - What is the optimum plan for the project if the time of activities b, c and d can be reduced progressively to one day at an extra cost as follows :

Activity	Cost pay day saved
b	Rs. 100
c	150
d	300

- (ii) how long it will take and how much it will cost compared with the normal expected completion time ?
(I.C.M.A., Pt. IV—Adapted)

ANSWER :

(a) Event

	Time of activity preceding the event	Earliest starting time	Earliest finishing time
d	10 days	0	0 + 10 = 10 days
e	6 "	10	10 + 6 = 16 "
f	4 "	16	16 + 4 = 20 "
c	6 "	0	0 + 6 = 6 "
b	4 "	0	0 + 4 = 4 "
a	4 "	4	4 + 4 = 8 "
Total activity time	34 days		

(b) The critical path is d, e, f with $10 + 6 + 4 = 20$ day's duration.

(c) Total cost of the project = Rs. 500 × 20 (days) + Rs. 200 × 34 (days) = Rs. 16,800.

(d) Saving of time :

for 1 day of d, cost reduction

$$= \text{Rs. } 500 - \text{Rs. } 300 = \text{Rs. } 200$$

for 1 day of d + c, cost reduction

$$= \text{Rs. } 500 - (\text{Rs. } 300 + \text{Rs. } 150) = \text{Rs. } 50$$

for 1 day of d + c + b, cost reduction

$$= \text{Rs. } 500 - (\text{Rs. } 300 + \text{Rs. } 150 + \text{Rs. } 100)$$

$$= (-) \text{Rs. } 50 \text{ (Extra cost)}$$

Days

Savings in days

Cost

		(Rs.)
19	1d = Rs. 200	16,800 - 200 = 16,600
18	2d = Rs. 400	16,800 - 400 = 16,400
17	3d = Rs. 600	16,800 - 600 = 16,200
16	4d = Rs. 800	16,800 - 800 = 16,000
15	4d + 1(d + c) = Rs. 850	16,800 - 850 = 15,950
14	4d + 2(d + c) = Rs. 900	16,800 - 900 = 15,900
13	4d + 3(d + c) = Rs. 950	16,800 - 950 = 15,850
12	4d + 4(d + c) = Rs. 1,000	16,800 - 1,000 = 15,800
11	4d + 4(d + c) + 1(d + c + b) = Rs. 950	16,800 - 950 = 15,850

Optimum plan will be 12 days as follows :

a—4 days

d—2 days (10—8)

b—4 days

e—6 days

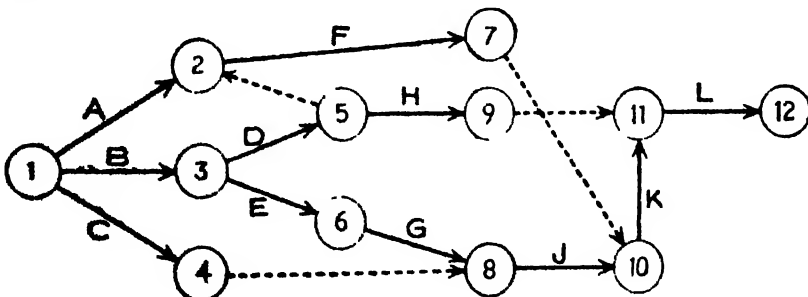
c—2 days (6—4)

f—4 days

Optimum plan cost = Rs. 15,800

Note : The cost of crashing given in the problem is the extra cost involved in addition to the direct cost of the activity per day. For example, the direct cost of activity, d for 10 days = Rs. 200 × 10 = Rs. 2,000 ; if the work is done in 9 days, the direct cost will be, Rs. 2,000 + Rs. 300 = Rs. 2,300 and the total cost including the indirect cost will be, Rs. 2,300 + Rs. 500 × 9 = Rs. 6,800, as against the normal cost of Rs. 7,000 (i.e. Rs. 200 × 10 + Rs. 500 × 10).

EXAMPLE 19.18.



In the given net work for a project, duration and cost of the activities are as shown below :

Activity	Duration in days	Direct cost (Rs.)
1- 2 A	10	110
1- 3 B	8	200
1- 4 C	6	100
3- 5 D	10	350
3- 6 E	2	50
2- 7 F	8	300
6- 8 G	3	70
5- 9 H	4	75
8-10 J	9	200
10-11 K	4	100
11-12 L	4	75

When activity 11-12 is completed, the project is finished.

- Calculate the earliest and latest time schedules and total float.
- If, besides the direct cost, there is an indirect cost of Rs. 100 per day for every day the project lasts, find the total cost of the project.
- What is the critical path ?
- If the project duration has to be reduced to 30 days with the following constraints, find the cheapest re-scheduling strategy.

Constraints :

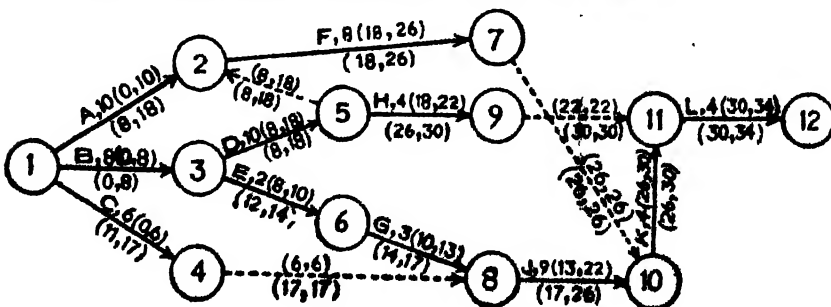
- Duration of A can be halved but at an additional cost of Rs. 110.
- Duration of B can be reduced to 4 days with an additional cost of Rs. 80 per day saved.
- Duration of K can be reduced at an additional cost of Rs. 70 per day saved and minimum days that can be reduced is limited to 3 days.

(I. C. W. A., Final)

ANSWER :

Activity	Earliest finishing time	Latest finishing time	Total float
(i)	(ii)	(iii)	(iv) [(iii) - (ii)]
1- 2 A	10	18	8
1- 3 B	8	8	0
1- 4 C	6	17	11
3- 5 D	18	18	0
3- 6 E	10	14	4
2- 7 F	26	26	0
6- 8 G	13	17	4
5- 9 H	22	30	8
8-10 J	22	26	4
10-11 K	30	30	0
11-12 L	34	34	0

The net work is redrawn below, showing the time and critical path ;



(The figures in the parenthesis above the lines indicate the earliest starting and finishing times and those below the lines indicate latest starting and finishing times.)

(ii) Project duration = 34 days (see (iii), below)

Total direct cost = Rs. (110 + 200 + 100 + 350 + 50 + 300 + 70 + 75 + 200 + 100 + 75)
= Rs. 1,630

Total cost = Rs. 1,630 + Rs. 100 × 34 = Rs. 5,030

(iii) Critical path is 1 → 3 → 5 → 2 → 7 → 10 → 11 → 12
= 8 + 10 + 0 + 8 + 0 + 4 + 4 = 34 days

(iv) Activity A is not on the critical path and has a total float of 8 days. Reduction in its duration by 5 days at an additional cost of Rs. 110 does not reduce the duration of the project. Reduction in the duration of B by 4 days, i.e. to 4 days will reduce the project duration to 30(34 - 4) days. The effect on cost will be :

Increase in direct cost = Rs. 80 × 4 = Rs. 320

Cost saved = Rs. 80

Cost saved per day = Rs. 20

Reduction in the duration of K by 3 days, i.e. to 1 day will reduce the project duration to 31(34 - 3) days. The effect on cost will be :

Increase in direct cost = Rs. 70 × 3 = Rs. 210

Reduction in direct cost = Rs. 100 × 3 = Rs. 300

Cost saved = Rs. 90

Cost saved per day = Rs. 30

The cheapest re-schedule will be to reduce K by 3 days and B by 1 day. Cost saved will be Rs. 30 × 3 + Rs. 20 × 1 = Rs. 110.

EXAMPLE 19.19.

The activities of a job are tabulated below with normal and crash-time and cost. Each job can be relaxed and compressed with cost differential.

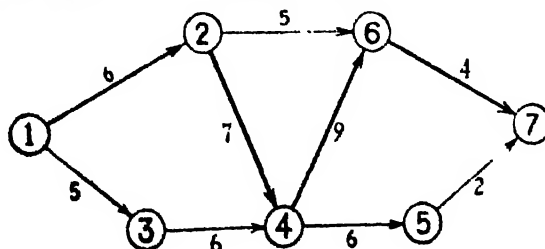
Activities	Normal		Crash	
	Cost (Rs.)	Time (hrs)	Cost (Rs.)	Time (hrs)
1-2	4	6	5	3
1-3	3	5	5	1
2-4	4	7	10	5
2-6	3	5	6	2
3-4	4	6	7	2
4-5	3	6	6	4
4-6	6	9	11	5
5-7	2	2	4	1
6-7	2	4	5	1
	31		59	

- Draw the net work corresponding to normal time. Tabulate the total and free floats against each activity. What is the normal duration and cost of the job ?
- Find out the crash duration of the job and its associated cost.
- Suitably crash the activities so that the normal duration may be reduced by 8 hrs. at a minimum cost. Redraw the net work. What is the job cost for this crashed duration ?

(I. C. W. A., Final)

ANSWER :

- The net work diagram corresponding to normal time is shown below :



The total and free floats against each activity are :

Activity	Normal Duration	Starting time		Completion time		Float	
		Earliest	Latest	Earliest	Latest	Total	Free
1-2	6	0	0	6	6	—	—
1-3	5	0	7	5	12	7	—
2-4	7	6	6	13	13	—	—
2-6	5	6	17	11	22	11	11
3-4	6	5	7	11	13	2	2
4-5	6	13	18	19	24	5	—
4-6	9	13	13	22	22	—	—
5-7	2	19	24	21	26	5	5
6-7	4	22	22	26	26	—	—

The critical path is 1 → 2 → 4 → 6 → 7 and, therefore, the normal duration of the job is 6 + 7 + 9 + 4 = 26 hours and normal cost = Rs. 31.

(b) With crash time for each activity as indicated in the problem, the critical path still remains the same, i.e. 1 → 2 → 4 → 6 → 7 and the crash duration of the job is 3 + 5 + 5 + 1 = 14 hours and the associated cost is Rs. 59.

(c) The slope of each activity $\left[\frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}} \right]$ is calculated as follows :

Activity	Slope	Activity	Slope
1-2	0.33	1-3	0.50
2-4	3.00	2-6	1.00
4-6	1.25	3-4	0.75
6-7	1.00	4-5	1.50
		5-7	2.00

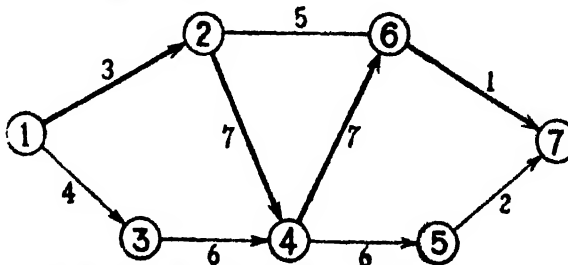
To reduce the normal duration of the job by 8 hours, the activities on the critical path may be selected starting with the least slope, i.e. 0.33 relating to activity 1-2. Thus, 1-2 can be crashed from 6 (normal) to 3 (crash), i.e. by 3 hours at an increase of cost of $0.33 \times 3 = \text{Rs. } 1$. Next, 6-7 can be crashed by 3 hours at increase of cost = $1.00 \times 3 = \text{Rs. } 3.00$. Lastly, 4-6 can be crashed by 2 hours at increase of cost = $1.25 \times 2 = \text{Rs. } 2.50$.

This gives the total reduction of duration by 8 hours. It is, however, seen that crashing of 1-2 by 3 hours makes it non-critical and 1-3 and 3-4 now fall on the critical path. Crashing of 1-2 in the third hour is, therefore, not possible unless either 1-3 or 3-4 is reduced by 1 hour. We select 1-3 because its slope is smaller than that of 3-4. Thus 1-3 is also reduced by 1 hour at a cost of $0.50 \times 1 = \text{Rs. } 0.50$.

Total increase in cost = Rs. 1 + Rs. 3 + Rs. 2.5 + Rs. 0.5 = Rs. 7

Total job cost = Rs. 31 + Rs. 7 = Rs. 38

The redrawn network is as follows :



Budgeting through Network Analysis. The inclusion of cost in network has provided an effective tool for budgeting project expenditure and for monitoring and controlling the financial status of a project. The various activities of a project are clubbed together to form suitable work packages in such a manner that each work package constitutes a responsibility centre for the purpose of control of costs. The costs for each work package are budgeted and represented in the net

work. The actual expenditure incurred is compiled periodically and compared with the budget. Since the network technique deals with time and cost, it is also possible to compare scheduled work with completed work.

The budget over-run/under-run may be determined in two ways. In the first method, the cost of completing the balance activities is estimated on the particular date and added to the actual expenditure incurred to date. This total compared with the budgeted cost for the project as a whole determines the over-run or under-run, as the case may be. In the other method, the 'earned value' of the work package, i.e. the budget allowance for the actual work done to date is compared with the actual expenditure incurred.

The budgetary control procedure through network may be graphically illustrated as shown in the diagram given below :

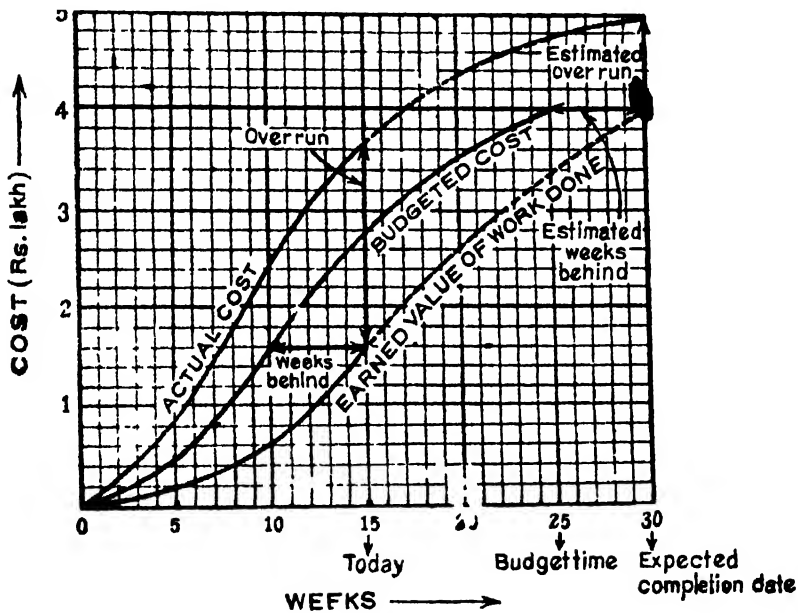


Fig. 19.23.

Data as ascertained from the graph are :

Date of evaluation of status

Actual cost till date

Budgeted value (earned value) of actual work

Budgeted time for actual work

Budgeted cost till date

Estimated actual costs of completion of project

Total budgeted cost on completion

Estimated time of completion of the project

Budgeted time of completion

End of 15th week

Rs. 3.7 lakh

Rs. 1.8 lakh

10 weeks

Rs. 2.8 lakh

Rs. 5 lakh*

Rs. 4 lakh

30 weeks*

25 weeks

* As estimated on date, i.e. at the end of 15th week.

Over-run on date = Actual cost on date — Earned value of work done
= Rs. 3.7 lakh — Rs. 1.8 lakh = Rs. 1.9 lakh

Over-run on completion = Actual cost of completion (as estimated on date) — Total budget cost of completion = Rs. 5 lakh — Rs. 4 lakh = Rs. 1 lakh

Budgeted cost of balance work on date = Rs. 4 lakh — Rs. 1.8 lakh = Rs. 2.2 lakh

This can be completed by incurring an estimated expenditure of Rs. 1.3 lakh (Rs. 5 lakh — Rs. 3.7 lakh)

Delay in activity on date	= 15 — 10 = 5 weeks
Delay in completion of the overall project	= 30 — 25 = 5 weeks

The above indicates that while the delay on date will not be made up and the project will be completed 5 weeks behind schedule, proportionately less expenditure will be incurred to complete the balance work. One of the likely reasons may be that a major portion of total fixed costs might have already been incurred in the initial stages of the project.

Resource Allocation and Load Smoothing. In our discussion of PERT and CPM techniques so far, we had assumed that unlimited resources such as labour (crew size), cost (finance), shop facilities (equipments), shop space (size), etc. were available to the management for the execution of the projects. When resources are limited, activities may be delayed and the usual notions of critical path and floats do not have significance. In such situations, two alternative courses of action are available depending upon whether the scheduled date of the job can be shifted or whether it is invariant, i.e. the date remains fixed and is not to be altered. In the first case, the activities are critically sequenced subject to the constraint of availability of resources and the minimum period of the project is re-determined accordingly. The process is known as *Resource Levelling*.

The technique adopted in the second situation, with which we are presently concerned here, is known as *Resource Smoothing* or *Load Smoothing*. When the demand for the resources varies from period to period, the allocation (known as *Resource Allocation*) is made in such a manner that the demand is smoothed and the maximum demand on any resource does not exceed a limit (pre-set by the constraint of availability of the resources). The technique is illustrated below :

EXAMPLE 19.20.

The duration and requirement of work force for each activity is tabulated below.

Activity	Duration (days)	No. of Men
1-2	8	4
1-3	7	10
1-5	12	5
2-3	4	6
2-4	10	7
3-4	3	5
3-5	5	8
3-6	10	7
4-6	7	11
5-6	4	3

(a) Depending on the interdependencies of activities, a CPM diagram may be translated to a bar chart of activities, indicating early start and finish times and available total and free floats.

This chart can be used for levelling the requirement of workforce.

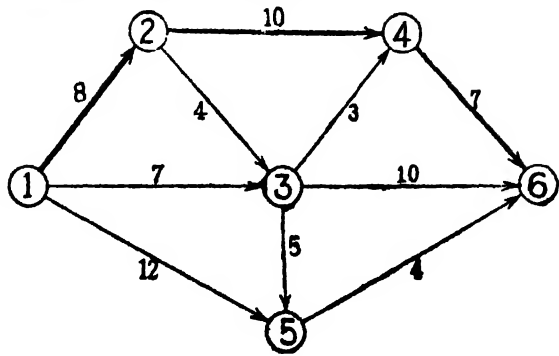
Draw a bar chart for the above problem.

(b) Find maximum and minimum workforce required after levelling the activities.

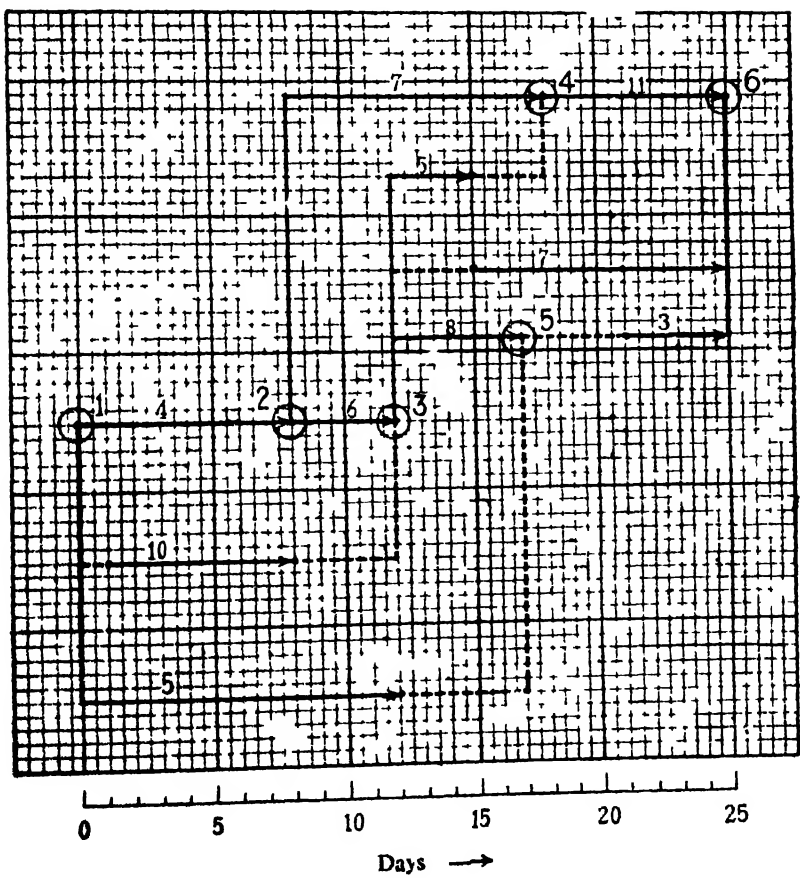
(I. C. W. A., Final)

ANSWER :

(a) The CPM diagram for the job or project is given below :



The CPM diagram when translated into a bar chart of activities will be as follows :



The manpower requirement (i.e. the crew size) is shown activity by activity over the bars. From this chart we can read out the early start and the late finish time and the available total and free floats as tabulated in the next page.

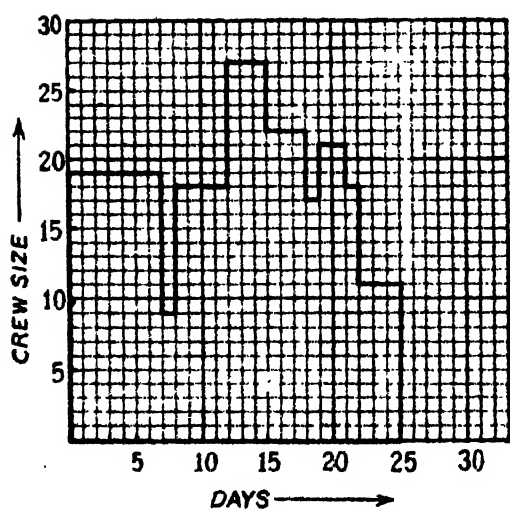
Activity	Early start	Latest finish	Float	
			Total	Free
1-2	0	8	—	—
1-3	0	15	8	5
1-5	0	21	9	5
2-3	8	15	3	—
2-4	8	18	—	—
3-4	12	18	3	3
3-5	12	21	4	—
3-6	12	25	3	3
4-6	18	25	—	—
5-6	17	25	4	4

(The critical path consisting of the activities 1-2-4-6 have no float.)

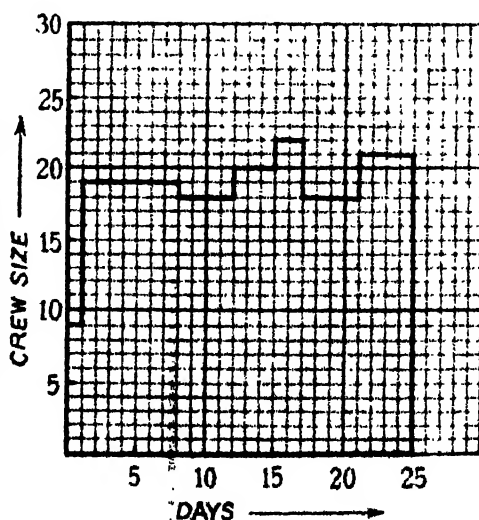
- (b) Based on the bar chart of activities, a resource or load histogram showing the requirement of men on each of the 25 days' period length of the project may be drawn as shown below (I).

It will be seen that there are peaks and valleys in the histogram indicating that on certain days, the requirement of crew size is heavy while on some other days the requirement is very low. We have, therefore, to smoothen the load in such a manner that the peaks are flattened, i.e. the objective is to spread over the available workforce in such a way that the requirements are brought down within a narrower range. This depends upon the float available so that if possible, the activities requiring high workforce may be suitably postponed to the days when less workforce is required.

In the diagram above, we find that the largest requirement is 27 men on the 13th, 14th and 15th days. If activity 3-6 (which has a float of 3 days) is delayed by 3 days, activity 5-6 (which has a float of 4 days) is delayed by 4 days, and activity 1-3 (which has a free float of 5 days) is delayed by one day, the revised histogram will be as follows (II) :-



I

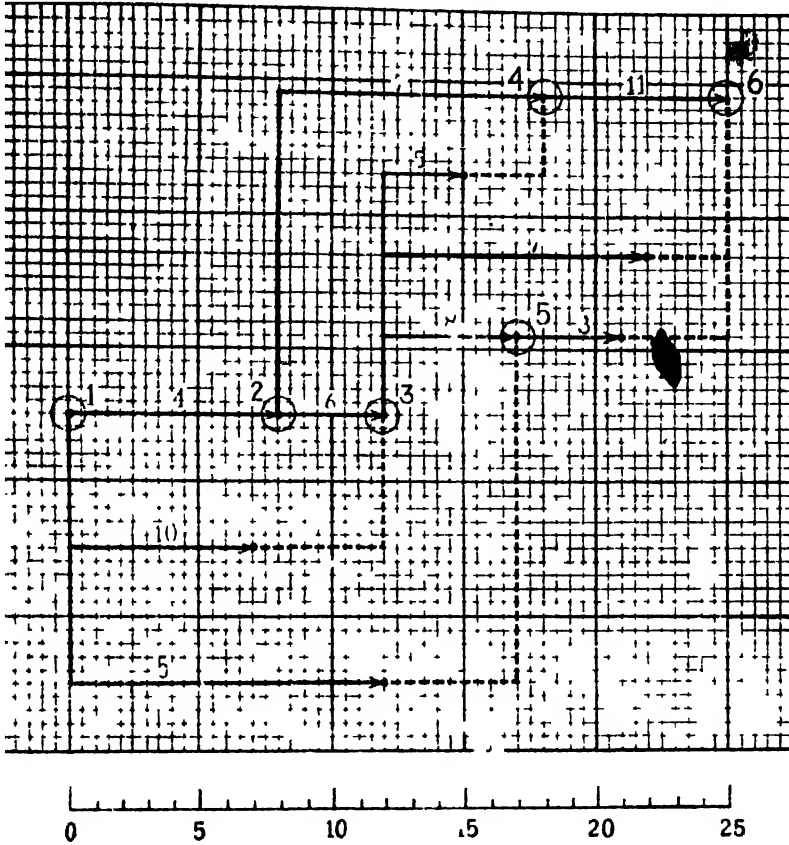


II

Next, we have to examine whether there is further scope for smoothening the peaks. If so, the process would be repeated till an optimum solution is arrived at. In the present case it is not possible to further reduce the peaks without repercussion elsewhere and no improvement to the solution can be made.

Thus we find from the histogram that the maximum workforce required is 22 men on the 16th and 17th days and the minimum is 9 men required on the 1st day. The minimum has been shifted to the first day to avoid the sudden drop in labour force after the work has sufficiently progressed ; the project would now start with 9 men and employ 19 men on the 2nd day. But for the requirement on the 1st day, the minimum would be 18 men.

The revised bar chart after smoothing is shown below :



Distinction between PERT and CPM Techniques. It was stated earlier that though PERT and CPM networks were developed independently and the procedures adopted for the two techniques were more or less common, the objectives were different. We may summarise here the basic differences between the two techniques :

- (i) While PERT is mainly for planning and scheduling research programmes, CPM is used for construction and business problems.
- (ii) Thus, PERT network is a probabilistic model, whereas CPM is a deterministic model which does not deal with uncertainty.
- (iii) PERT calculates the expected duration of an activity as the weighted average of three time estimates and uses statistical methods to determine deviations from the probability of the estimated time.

- (iv) The concept of crashing is applied mainly to CPM models. CPM deals with costs of project schedules and their minimization.

Advantages of Network Techniques. PERT and CPM techniques are useful aids for the project management who undertake non-repetitive project works. The main advantages of these techniques may be summarised as follows :—

- (i) Network techniques are powerful tools for planning, scheduling and control. At the planning stage, the various tasks to be performed and the resource requirement for accomplishing those tasks are laid out. Network analysis assists at this stage, when alternative programmes are being considered. At the scheduling stage, network calculates the time and resources needed at each stage of production or activity. Finally in the operational phase, the network is useful as a control device for measuring the actual against the planned performance.
- (ii) Network shows in a simple way, the inter-relationship of the various activities constituting a project or a programme. This helps in bringing out clearly the technological inter-dependence of the various activities and so, integrating the project planning.
- (iii) Network points to the smallest critical areas and the exceptional problems so that corrective action may be taken in time.
- (iv) CPM deals with time-cost trade off and determines the optimum schedule for a project. Crashing programmes assist in avoiding resource bottlenecks.
- (v) Cost control can be exercised on project basis. For this purpose, activity or work package is treated as a cost centre.

EXAMINATION QUESTIONS

1. What is the role of Operation Research in decision-making ? Explain the scopes and methodology of Operation Research, the main phases of Operation Research and the techniques used in solving Operations Research problems. (I. C. W. A., Final)
2. Using the graphical method, maximize the function $19x + 9y$, subject to the following :

$$\begin{aligned} 4x + 9y &\leq 180 \\ 19x + 70y &\leq 1,330 \\ 5x + 7y &\geq 175 \\ 5x + 3y &\geq 150 \end{aligned}$$

Also solve the problem using the simplex method.

3. On the basis of the following information in respect of an engineering concern, which is the product mix which will give the highest profit attainable ?

Products manufactured	A	B	C
Raw material per unit	10 kgs.	6 kgs.	15 kgs.
Labour hours per unit @ Re. 1 per hour	15	25	20
Sales price per unit	Rs. 125	Rs. 100	Rs. 200
Maximum production possible	6,000 units	4,000 units	3,000 units

1,00,000 kgs raw materials are available @ Rs. 10 per kg. Maximum production hours are 1,84,000.

4. A small firm has two production sections, namely, manufacturing and packing. The total available daily production time in these sections is 400 minutes and 320 minutes respectively. A choice between three products A, B and C in any possible combination is open for production

planning. Raw materials, labour and other facilities required are available in sufficient quantities to meet any programme that can be formulated within the plant capacity. The Sales Department is also geared to sell all that is produced. Product A needs 12 minutes of manufacturing time per unit of output and 4 minutes of packaging time ; Product B requires 4 minutes each of manufacturing and packaging per unit ; and C needs 8 minutes of manufacturing but 24 minutes of packaging per unit. The contributions per unit of A, B and C are respectively Rs. 12, Rs. 8 and Rs. 24, and the total fixed charges per day come to Rs. 500. Advise about the best possible production programme under these circumstances.

(I. C. W. A., Final)

- 5 Formulate the initial simplex table for maximising profit of a company manufacturing products A, B, C, D, E and F. The time needed to manufacture these products for each operation and machine group are listed below in a table. The profit contributions of A, B, C, D, E and F are Re. 0.40, Re. 0.28, Re. 0.32 Re. 0.72 Re. 0.64 and Re. 0.60 respectively.

Operation	Machine Group	A Hours	B Hours	C Hours	D Hours	E Hours	F Hours	Total available
(1)	Lathe	0.01	0.01	0.01	0.03	0.03	0.03	0.856
(2)	Mill A	—	—	—	0.05	—	—	0.700
	Mill B	0.02	0.02	—	—	0.05	—	0.100
	Mill C	—	—	0.03	—	—	0.08	0.900

(I. C. W. A. Final)

6. (a) Determine $x, y \geq 0$, which maximises $z = 2x + 5y$, subject to

$$x \leq 4, y \leq 3 \text{ and } 2y \leq 8$$

(a) Show that in three iteration tables of z are successively increased from zero to 15 to 19, for the sets of values of $(x = 0, y = 0)$, $(x = 0, y = 3)$ and $(x = 2, y = 3)$ respectively. Solve the problem graphically and show that in simplex tables, the solution moves from one corner to the other of the solution space of the graphical method of solution and hence simplex is an iterative method improving one solution with respect to the other.

7. Two products, p_1 and p_2 pass through three machining processes, M_1 , M_2 and M_3 . Details are as follows :

	P_1 Hours	P_2 Hours	Constraint of total hours
M_1	150	60	30,000
M_2	50	60	13,000
M_3	10	20	5,000
Profit per unit	Rs. 200	Rs. 100	

Determine the production schedule which will optimise the profit.

(I. C. W. A., Final)

8. Two products A and B are processed in 3 machine centres I, II, and III each having available capacity as 80 hours, 240 hours and 160 hours respectively. The requirement of machine hours for each job is indicated by the table :

	A	B
I	2	1
II	4	4
III	3	4

Profit from each unit of A and B is Rs. 70 and Rs. 50 respectively.

- (a) Using simplex table find an optimum production pattern.

- (b) Ascertain from the final table, whether there is any surplus capacity of machine centre II.

(I. C. W. A., Final)

9. The final simplex table for optimum solution of a linear programming problem having two products and three limited resources is given below :

x_1	C_j	x_2	x_3	x_4	x_5	x_6	x_7
x_1	4	333	1	0	-1	2	0
x_2	0	117	0	0	-2	1	1
x_3	5	83	0	1	2	-1	0
C_j			4	5	0	0	0
Z_j		1747	4	5	6	3	0
$Z_j - C_j$			0	0	6	3	0

Study the following from the above table :

- Profit optimising product mix and maximum profit.
 - What is the meaning of shadow price ? Where is it shown in his table ? Explain it in respect of resource x_3 .
 - Is there any resource surplus ? What is that and to what extent ?
 - Management decides to utilise that surplus completely by introducing any one of the two other resources in the production line. To what extent either of them may be introduced ? Find the effect on profitability in those cases. (I. C. W. A., Final)
10. The products P, Q and R being produced in a plant have profit margin as Rs. 3, Rs. 5 and Rs. 4 respectively. The raw materials A, B and C are of scarce supply and the availability is limited to 8, 15 and 10 units respectively. Consumption is indicated in the table below.

	P	Q	R
A	2	3	—
B	3	2	4
C	—	2	5

- Write down the problem mathematically for maximisation of profit margin.
 - Solve the problem by simplex method for obtaining optimum production pattern.
 - What are the opportunity costs of each of the raw material ? (I. C. W. A., Final)
11. The products of two Plants A and B are to be transported to three Warehouses W_1 , W_2 and W_3 . The cost of transportation of each unit from Plants to the Warehouses along with the normal capacities of Plants and Warehouses are indicated below.

Plants	Warehouses			Capacities
	W_1	W_2	W_3	
A	25	17	25	300
B	15	10	18	500
Demands	300	300	500	1100/800

- Solve the problem for minimum cost of transportation. Are there any alternative solutions ? If any, explain the methodology of solving.
- Overtime can be used in each plant to raise the capacity by 50% of the normal but the corresponding cost of transshipment will also increase by 10 and 15 for plants A and B respectively.

Again solve the problem for minimum cost of transportation.

(I. C. W. A., Final)

12. (a) The standard weight of a special purpose brick is 5 kg. and it contains two basic ingredients B1 and B2. B1 costs Rs. 5 per kg. and B2 costs Rs. 8 per kg. Strength considerations dictate that the brick contains not more than 4 kg. of B1 and a minimum of 32 kg. of B2. Since the demand for the product is likely to be related to the price of the brick, find out graphically the minimum cost of the brick satisfying the above conditions.

(b) A stereo equipment manufacturer can produce two models A and B of 40 and 80 watt total music power each. Each model passes through three manufacturing divisions 1, 2 and 3 where model A takes 4, 2.5 and 4.5 hours each and B model takes 2, 1 and 1.5 hours each. The three divisions have a maximum of 1600, and 1200 and 1600 hours every month respectively.

Model A gives a contribution of Rs. 400 each and B gives Rs. 100 each. Assuming abundant product demand, find out the optimum product mix and the maximum contribution through the Simplex Method. *(I. C. W. A. Final)*

13. A furniture company can produce four types of chairs. Each chair is first made in the Carpentry shop and then varnished, waxed and polished in the Finishing shop. Man hours required in each shop are :

Chair type	1	2	3	4
Carpentry Shop	4	9	7	10
Finishing Shop	1	1	3	40
Contribution per chair (Rs.)	12	20	18	40

Total number of man hours available per month in Carpentry and Finishing Shops are 6,000 and 4,000 respectively. Assuming abundant supply of raw material and demand for finished products, determine the number of each type of chairs to be produced for profit maximisation using the Simplex Method.

14. 'A ladies' fashion shop wishes to purchase the following quantities of summer dresses :

Dress size	I	II	III	IV
Quantity	100	200	450	150

Three manufacturers are willing to supply dresses. The quantities given below are maximum they are able to supply of any given combination of orders for dresses :

Manufacturer	A	B	C
Total quantity	150	450	250

The shop expects the profit per dress to vary with the manufacturer as given below :

Manufacturer	Sizes			
	I	II	III	IV
A	2.50	4.00	5.00	2.00
B	3.00	3.50	5.50	1.50
C	2.00	4.50	4.50	2.50

You are required to :

- (a) Use the transportation technique to solve the problem of how the orders should be placed on the manufacturers by the fashion shop in order to maximise profit.
- (b) Explain how you know that there is no further improvement possible, showing your workings. *(I.C.M.A., Pt. IV)*
15. There are 4 jobs A, B, C, and D and these are to be performed on 4 machine centres I, II, III and IV. One job is to be allocated to a machine centre, though each machine is capable of doing any job, at different costs given by the matrix below :

Jobs	Machine Centres			
	I	II	III	IV
A	5	4	2	4
B	3	2	5	4
C	1	4	2	3
D	2	3	4	5

- (a) Find an allocation of the jobs to the machine centres so that the total cost of processing would be minimum.
- (b) If machine centre IV goes out of order, which jobs will be then allocated to the rest of the centres at minimum cost ? *(I.C.W.A., Final)*

16. A canning company distributes the products of 3 factories to 5 warehouses all situated at different locations. All products are identical. The production capacities of the factories, demand of each warehouse and the cost of transportation of unit material from each of the factories to the warehouses are given in the table below. Find a suitable pattern of distribution at a minimum cost.

	W_1	W_2	W_3	W_4	W_5	Capacity
F_1	20	28	32	55	70	50
F_2	48	36	40	44	25	100
F_3	35	55	22	45	48	150
Demand	100	70	50	40	40	300

(I.C.W.A., Final)

17. The following table gives factory-to-warehouse shipping costs (in rupees), quantities available and quantities required (in tonnes) at each factory and each warehouse respectively. Determine the shipping schedule that will minimise the shipping costs while satisfying the requirements of each of the four warehouses :

Factories	Warehouses					Available at factory (in tonnes)
		A	B	C	D	
		Rs.	Rs.	Rs.	Rs.	
F_1		13	11	15	20	2
F_2		17	14	12	13	6
F_3		18	18	15	12	7
Requirement of warehouses (in tonnes)		3	3	4	5	15

Make any cogent assumption for the purpose of your answer. *(I.C.W.A., Final)*

18. Average time taken by an operator on a specific machine is tabulated below. The management is considering to replace one of the old machines by a new one and the estimated time for operation by each operator on the new machine is also indicated.

Operators	Machines						New
	1	2	3	4	5	6	
A	10	12	8	10	8	12	11
B	9	10	8	7	8	9	10
C	8	7	8	8	8	6	8
D	12	13	14	14	15	14	11
E	9	9	9	8	8	10	9
F	7	8	9	9	9	8	8

- (a) Find out an allocation of operators to the old machines to achieve a minimum operation time.
- (b) Reset the problem with the new machine and find out the allocation of the operators to each machine and comment on whether it is advantageous to replace an old machine to achieve a reduction in operating time only.
- (c) How will the operators be reallocated to the machines after replacements ?

(I.C.W.A., Final)

19. (a) Anand Batteries have plants at X, Y and Z. Its product 'torch batteries' is sent in trucks to its warehouses situated at A, B, C, and D for final delivery. The shipment, production runs and storage capacities are given on the bases of truckloads per week. The costing for transportation is also on the basis of truckloads.

The plants have their working capacities and the warehouses are of different sizes depending on market demand. The following tables show :

- (i) the capacity details of the plants and the warehouses and
(ii) the transportation cost per truckload.

Table 1

Warehouse	Capacity (truckloads)	Factory	Production (truckloads)
A	16	X	48
B	20	Y	32
C	40	Z	40
D	44	—	—
Total	120		120

Table 2

Transportation cost per truckload in units of Rs. 100

	A	B	C	D
X	6	11	3.5	6
Y	2	6	5	4
Z	1.5	11	4.5	3

You are required to work out as to how the supplies from the plant be allocated to the warehouses to minimise the total transportation cost.
Determine the minimum total transportation cost.

- (b) A Company has three plants at locations A, B and C which supply to warehouses located at D, E, F, G and H. Monthly plant capacities are 800, 500 and 900 units respectively. Unit transportation costs (in rupees) are given below :

		To				
		D	E	F	G	H
From	A	5	8	6	6	3
	B	4	7	7	6	6
	C	8	4	6	6	3

By using Vogel's approximation method, determine an optimum distribution for the company, in order to minimise the total transportation cost.
Also determine the minimum total transportation cost. (I.C.W.A., Final)

20. The products of three plants F_1 , F_2 , and F_3 are to be transported to 5 warehouses W_1 , W_2 , W_3 , W_4 and W_5 . The capacities of plants and warehouses and the cost of transportation from one plant to various warehouse are indicated in the following table.

	W_1	W_2	W_3	W_4	W_5	Plant capacity
F_1	74	56	54	62	68	400
F_2	58	64	62	58	54	500
F_3	66	70	52	60	60	600
Warehouse demand	200	280	240	360	320	

Determine the minimum cost of transportation.

(I.C.W.A., Final)

21. Three products A, B and C are produced in three machine centres X, Y and Z. Each product involves operation of each of the machine centres. The time required for each operation on various products are indicated in the table. 100, 77 and 80 hours are only available at machine centres X, Y, Z respectively.

The profit per unit of A, B and C products are Rs. 12, Rs. 3 and Re. 1 respectively.

Machine Centres

Products	X	Y	Z	Profit per unit
A	10	7	2	Rs. 12
B	2	3	4	Rs. 3
C	1	2	1	Rs. 1
Available Hrs.	100	77	80	

- (a) Find out a ^{yes} suitable product mix so as to maximise the profit. Comment on the queries (b) and (c) from the solution table so obtained.
- (b) Satisfy that full available hours of X and Y had been utilised and there is surplus hours of Z. Find out the surplus hours of Z.
- (c) Your object is to utilize surplus capacity of Z. Can you say from the table that introduction of more units of Y is required? (I.C.W.A., Final)
22. Five different machines can process any of the five required jobs as follows, with different profits resulting from each assignment,

Machine Job	A	B	C	D	E
1	30	37	40	28	40
2	40	24	27	21	36
3	40	32	33	30	35
4	25	38	40	36	36
5	29	32	41	34	39

Find out the maximum profit possible through optimum assignment.

(I.C.W.A., Final)

23. (a) Show that an assignment problem does not change structure if each row and column is reduced by a constant. Explain how this property can be used to find the solution of an assignment problem.
- (b) Six men are available for six different jobs. From past records the time in hours taken by different persons for different jobs are given below :

Men	1	2	3	4	5	6
1	2	9	2	7	9	1
2	6	8	7	6	14	1
3	4	6	5	3	8	1
4	4	2	7	3	10	1
5	5	3	9	5	12	1
6	9	8	12	13	9	1

Find out an allocation of men to different jobs which will lead to minimum operation time.

(I.C.W.A., Final)

24. Following are the man-power requirements for each activity in a project.

Activity	Normal time (days)	Man-power required per day
1-2	10	2
1-3	11	3
2-4	13	4
2-6	14	3
3-4	10	1
4-5	7	3
4-6	17	5
5-7	13	3
6-7	9	8
7-8	1	11

- (i) Draw the network and find out 'total float' and 'free float' for each activity.
(ii) The contractor stipulates that during the first 26 days only 4 to 5 men and during the remaining days 8 to 11 men only can be made available. Rearrange the activities suitably for levelling the man-power resources satisfying the above condition. (I.C.W.A., Final)
25. The estimated duration of each of the following ten jobs comprising a small maintenance project is given below :

Job	Estimated duration (days)	Job	Estimated duration (days)
(1, 2)	2	(4, 6)	6
(2, 3)	3	(4, 7)	2
(2, 4)	5	(5, 8)	8
(3, 5)	4	(6, 8)	7
(3, 6)	1	(7, 8)	4

Draw the net work diagram representing the project and calculate the early and late occurrence times for each event. Which jobs are critical and how much slack, if any, do the jobs (3, 5), (4, 6) and (7, 8) contain? Which of the jobs have free slack and to what extent?

If the job (2, 3) were to take 6 days instead of 3, how would the finish date of the project be affected? (I.C.W.A., Final)

26. A major project having 500 milestone events is controlled with the help of PERT techniques. You have been appointed for introduction of PERT costing system to that project for cost control purposes. Write a short note on the various features of PERT on the following lines :—
- Meaning of the term.
 - Break up of work packages cost centres.
 - Estimation of time for each element.
 - Associated direct and indirect cost.
 - Slope of activities.
 - Effect of crashing and relaxation of activities.
 - Optimum time — cost trade off.
- (I.C.W.A., Final)

27. The activities of a project are indicated below with normal duration and cost along with crash duration and cost. Assume the crashing cost is proportional at intermediate stages.

Activities	Normal Duration	Normal Cost	Crash Duration	Crash Cost
1—2	6	100	4	120
2—3	9	200	5	280
2—4	3	80	2	110
3—4	0	0	0	0
3—5	7	150	5	180
4—6	8	250	3	375
4—7	2	120	1	170
5—8	1	100	1	100
6—8	4	180	3	20
7—8	5	130	2	220

- (a) Draw the network.
- (b) Find the slope of each activity.
- (c) Evaluate the cost of crashing the project duration by 12 days.
- (d) Is that the maximum possible crashing ? (I.C.W.A., Final)

28. For a major capital intensive plant, design and engineering, procurement of equipments, erection and commissioning, all are controlled with the help of PERT net work.

Give your understanding on the following lines :—

- (i) Monitoring of a network and its essential steps.
- (ii) Resource levelling to be followed in scheduling.
- (iii) Reporting the slippages of milestones to the top management (a suitable proforma).
- (iv) Master control chart and Department charts.

(I.C.W.A., Final)

29. A project has the following characteristics :

Activity	Time	Activity	Time
1—2	2	4—5	5
1—4	2	4—8	8
1—7	1	5—6	4
2—3	4	6—9	3
3—6	1	7—8	3
		8—9	5

- (a) Construct PERT network and find critical path and time duration of the project. Activities 2-3, 4-5, 6-9 each requires one unit of the same key equipment to complete it. Do you think availability of one unit of the equipment in the organisation is sufficient for completing the project delaying it, if so, what is the schedule of these activities ?

(I.C.W.A., Final)

- 30. (a) What do you understand by the term direct cost and indirect cost in PERT costing techniques ? How do they behave in project cost with range of duration ?
- (b) What are dummies ? How do they play a vital role in PERT diagrams ?
- (c) Illustrate how the free floats are used in scheduling.
- (d) Design a suitable form for reporting the slippages of activities of a project to the top management.

(I.C.W.A., Final)

31. The following table gives the data relating to a project :

Activity	Normal		Crash	
	Time (Weeks)	Direct cost Rs.	Time (Weeks)	Direct cost Rs.
1—2	8	7,000	3	10,000
1—3	4	6,000	2	8,000
2—3	0	0	0	0
2—5	6	9,000	1	11,000
3—4	7	2,500	5	3,000
4—6	12	10,000	8	16,000
5—6	15	12,000	10	16,000
5—7	7	12,000	6	14,000
6—8	5	10,000	5	10,000
7—8	14	6,000	7	7,400
7—9	8	6,000	3	12,000
8—9	6	6,000	4	7,800
Total		86,500		1,15,200

Indirect cost per week is Rs. 1,000

By using the iterative procedure, you are required to draw network diagram and determine, by trading off between Time and Cost Parameters.

- (i) the optimum projected completion time,

- (ii) the critical path(s), and
- (iii) the minimum total cost of project completion.

(I.C.W.A., Final)

32. A project with the following activities, duration and manpower requirements is given below :

Activity	Duration	Manpower requirement
1—2	2	5
1—3	2	4
1—4	0	0
2—5	2	2
2—6	5	3
3—7	4	6
4—8	5	2
5—9	6	8
6—9	3	7
7—8	4	4
8—9	6	3

- (a) Draw a network diagram of the project indicating the earliest start, latest start, earliest finish, latest finish, total float and free float of each activity—
- (b) There are 11 persons who can be employed for this project. Carry out appropriate manpower levelling so that the fluctuation of work force requirement from day to day is as small as possible.

(I.C.W.A., Final)

33. In a railway Marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that the inter-arrival time follows an exponential distribution and the service time distribution is also exponential with an average 36 minutes. Calculate the following :—

- (i) The mean queue size (line length),
- (ii) The probability that the queue size exceeds 10

(I.C.W.A., Final)

34. Two children each with a few rupee coins are playing a game like this :

'Each of A and B (the two children) tosses a coin. If the coins are the same both heads or both tails, A takes both. If they are different, B takes both.'

Draw the flow chart for this game situation

(I.C.W.A., Final)

APPENDICES

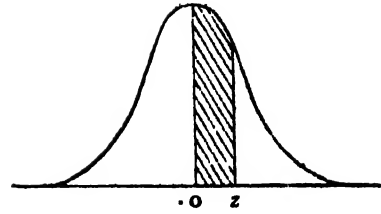


TABLE 1
Areas of a Standard Normal Distribution, $F(Z)$

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2703	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997

The entries in the Table indicate the proportions under the curve that lie between $Z = 0$ and $+Z$. The proportions between $Z = 0$ and $-Z$ are obtained by symmetry.

TABLE 2

$$PV = (1 + r)^{-n} = \frac{1}{(1 + r)^n}$$

n/r	5%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%
1	0.952	0.943	0.926	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800
2	0.907	0.890	0.857	0.826	0.797	0.769	0.756	0.743	0.718	0.694	0.672	0.650	0.640
3	0.864	0.840	0.794	0.751	0.712	0.675	0.658	0.641	0.609	0.579	0.551	0.524	0.512
4	0.823	0.792	0.735	0.683	0.636	0.592	0.572	0.552	0.516	0.482	0.451	0.423	0.410
5	0.784	0.747	0.681	0.621	0.567	0.519	0.497	0.476	0.437	0.402	0.370	0.341	0.328
6	0.746	0.705	0.630	0.564	0.507	0.456	0.432	0.410	0.370	0.335	0.303	0.275	0.262
7	0.711	0.665	0.583	0.513	0.452	0.400	0.376	0.354	0.314	0.279	0.249	0.222	0.210
8	0.677	0.627	0.540	0.467	0.404	0.351	0.327	0.305	0.266	0.233	0.204	0.179	0.168
9	0.645	0.592	0.500	0.424	0.361	0.308	0.284	0.263	0.225	0.194	0.167	0.144	0.134
10	0.614	0.558	0.463	0.368	0.322	0.270	0.247	0.227	0.191	0.162	0.137	0.116	0.107
11	0.585	0.527	0.429	0.350	0.287	0.237	0.215	0.195	0.162	0.135	0.112	0.094	0.086
12	0.557	0.497	0.397	0.319	0.257	0.208	0.187	0.168	0.137	0.112	0.092	0.076	0.069
13	0.530	0.469	0.368	0.290	0.229	0.182	0.163	0.145	0.116	0.093	0.075	0.061	0.055
14	0.505	0.442	0.341	0.263	0.205	0.160	0.141	0.125	0.099	0.078	0.062	0.049	0.044
15	0.481	0.417	0.316	0.239	0.183	0.140	0.123	0.108	0.084	0.065	0.051	0.040	0.035
16	0.458	0.394	0.292	0.218	0.163	0.123	0.107	0.093	0.071	0.054	0.042	0.032	0.028
17	0.436	0.371	0.270	0.198	0.146	0.108	0.093	0.080	0.060	0.045	0.034	0.026	0.023
18	0.416	0.350	0.250	0.180	0.130	0.095	0.081	0.069	0.051	0.038	0.028	0.021	0.018
19	0.396	0.331	0.232	0.164	0.116	0.083	0.070	0.060	0.043	0.031	0.023	0.017	0.014
20	0.377	0.312	0.215	0.149	0.104	0.073	0.061	0.051	0.037	0.026	0.019	0.014	0.012

TABLE 3

Present Value of Annuity of Re. 1 received per period for n Periods

$$PV = 1 - (1 + r)^{-n}$$

n/r	5%	6%	8%	10%	12%	14%	15%	16%	18%	20%	22%	24%	25%
1	0.952	0.943	0.926	0.909	0.893	0.877	0.870	0.862	0.847	0.833	0.820	0.806	0.800
2	1.859	1.833	1.783	1.736	1.690	1.647	1.626	1.605	1.566	1.528	1.492	1.457	1.440
3	2.723	2.673	2.577	2.487	2.402	2.322	2.283	2.246	2.174	2.106	2.042	1.981	1.952
4	3.546	3.456	3.312	3.169	3.037	2.914	2.855	2.798	2.690	2.589	2.494	2.404	2.362
5	4.330	4.212	3.993	3.791	3.605	3.433	3.352	3.274	3.127	2.991	2.864	2.745	2.689
6	5.076	4.917	4.623	4.355	4.111	3.889	3.784	3.685	3.498	3.326	3.167	3.020	2.951
7	5.786	5.582	5.206	4.868	4.564	4.288	4.160	4.039	3.812	3.605	3.416	3.242	3.161
8	6.463	6.210	5.747	5.335	4.968	4.639	4.487	4.344	4.078	3.837	3.619	3.421	3.329
9	7.108	6.802	6.247	5.759	5.328	4.946	4.772	4.607	4.303	4.031	3.786	3.566	3.463
10	7.722	7.360	6.710	6.145	5.650	5.216	5.019	4.833	4.494	4.192	3.923	3.682	3.571
11	8.306	7.887	7.139	6.495	5.937	5.453	5.234	5.029	4.656	4.327	4.035	3.776	3.656
12	8.863	8.384	7.536	6.814	6.194	5.660	5.421	5.197	4.793	4.439	4.127	3.851	3.725
13	9.394	8.853	7.904	7.103	6.424	5.842	5.583	5.342	4.910	4.533	4.203	3.912	3.780
14	9.899	9.295	8.244	7.367	6.628	6.002	5.724	5.468	5.008	4.611	4.265	3.962	3.824
15	10.380	9.712	8.559	7.606	6.811	6.142	5.847	5.575	5.092	4.675	4.315	4.001	3.859
16	10.838	10.106	8.851	7.824	6.974	6.265	5.954	5.669	5.162	4.730	4.357	4.033	3.887
17	11.274	10.477	9.122	8.022	7.120	6.373	6.047	5.749	5.222	4.775	4.391	4.059	3.910
18	11.690	10.828	9.372	8.201	7.250	6.467	6.128	5.818	5.273	4.812	4.419	4.080	3.928
19	12.085	11.158	9.604	8.365	7.366	6.550	6.198	5.877	5.316	4.844	4.442	4.097	3.942
20	12.462	11.470	9.818	8.514	7.469	6.623	6.259	5.929	5.353	4.870	4.460	4.110	3.954

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